



Stormwater Treatment Area 2 Cell 4 Expansion Project

Basis of Design Report



CN040935-WO04

BROWN AND
CALDWELL

May 2005

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May 12, 2005

Ms. Maria Clemente, P.E.
Project Manager
South Florida Water Management District
3301 Gun Club Road
West Palm Beach, FL 33406

Subject: Contract CN040935-WO04
STA 2/Cell 4 Expansion Project
Basis of Design Report

Dear Ms. Clemente:

Brown and Caldwell, in association with Taylor Engineering, Inc., Radise International, SFRN Inc., and Weidener Surveying and Mapping, P.A., is pleased to submit this report documenting our team's work for the Basis of Design Report of the STA 2/Cell 4 Expansion Project. This submittal represents work in accordance with Contract CN040935-WO04 between Brown and Caldwell and the District.

This report includes revisions from the Draft Basis of Design Report, dated March 21, 2005 reflecting comments and suggestions received during the review of the draft document. Also included in this report in Appendix L are the review comments received on the draft report and Brown and Caldwell's responses to those comments.

We have enjoyed working with you and the many other District staff whose assistance has been most valuable to this project. We look forward to the next phase of the project developing the detailed design documents. Should there be any further questions regarding the work documented in this report, please do not hesitate to contact me.

Sincerely,

BROWN AND CALDWELL



James E. Siegfried, P.E.
Project Manager

Enclosures



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Acronyms

BODR	Basis of Design Report
cfs	cubic feet per second
DMSTA	Dynamic Model for Stormwater Treatment Areas
DRT	Design Review Team
EAA	Everglades Agricultural Area
ECP	Everglades Construction Project
ECT	Environmental Consulting & Technology, Inc.
EFA	Everglades Forever Act of 1994 and as amended in 2003
EPA	Everglades Protection Area
FDEP	Florida Department of Environmental Protection
fpd	feet per day
fps	feet per second
FP&L	Florida Power & Light
LIT	Level Indicating Transmitter
NNRC	North New River Canal



PIR	Project Implementation Report
PMS	Probable Maximum Storm
ppb	parts per billion
PSTA	periphyton stormwater treatment area
SAV	submerged aquatic vegetation
STA	Stormwater Treatment Area
TP	total phosphorus
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
USFWS	United States Fish & Wildlife Service
WCA	Water Conservation Area
WRAC	Water Resources Advisory Commission



Executive Summary

This Basis of Design Report (BODR) documents work performed by the Brown and Caldwell consultant team (BC Team) for the South Florida Water Management District (District) related to the Cell 4 expansion of Stormwater Treatment Area 2 (STA 2/Cell 4 Expansion Project). The STA 2/Cell 4 Expansion Project is part of the Long Term Plan for Achieving Water Quality Goals, implementation of which is mandated under the Everglades Forever Act (EFA). The STA-2/Cell 4 Expansion Project is being completed on a fast-track basis under the District's Acceler8 Program.

Background

The existing STA 2 is a 6,430-acre constructed wetland treatment system located in southern Palm Beach County between the North New River Canal (NNRC) and Water Conservation Area (WCA) 2A. STA 2 is presently divided into three treatment cells which operate in parallel. Inflow water is conveyed to the STA through an inflow canal from the S-6 pumping station and G-328 agricultural pumping station. Treated water is discharged to WCA 2A through the G-335 pumping station. The S-6 and G-328 pumping stations are designed to deliver a maximum flow of 3,370 cubic feet per second (cfs), and a maximum flow capacity of 3,040 cfs at G-335.

The original design of STA 2 was based on achieving a long-term annual average total phosphorus (TP) concentration of 50 parts per billion (ppb) in the Everglades Protection Area (EPA). Average annual TP water column concentrations in discharges from STA 2 are currently below 20 ppb as the District continues its work toward optimizing STA operations. For water year 2004 (October 1, 2003 through September 30, 2004), the average flow weighted mean outflow TP concentration was 14 ppb.

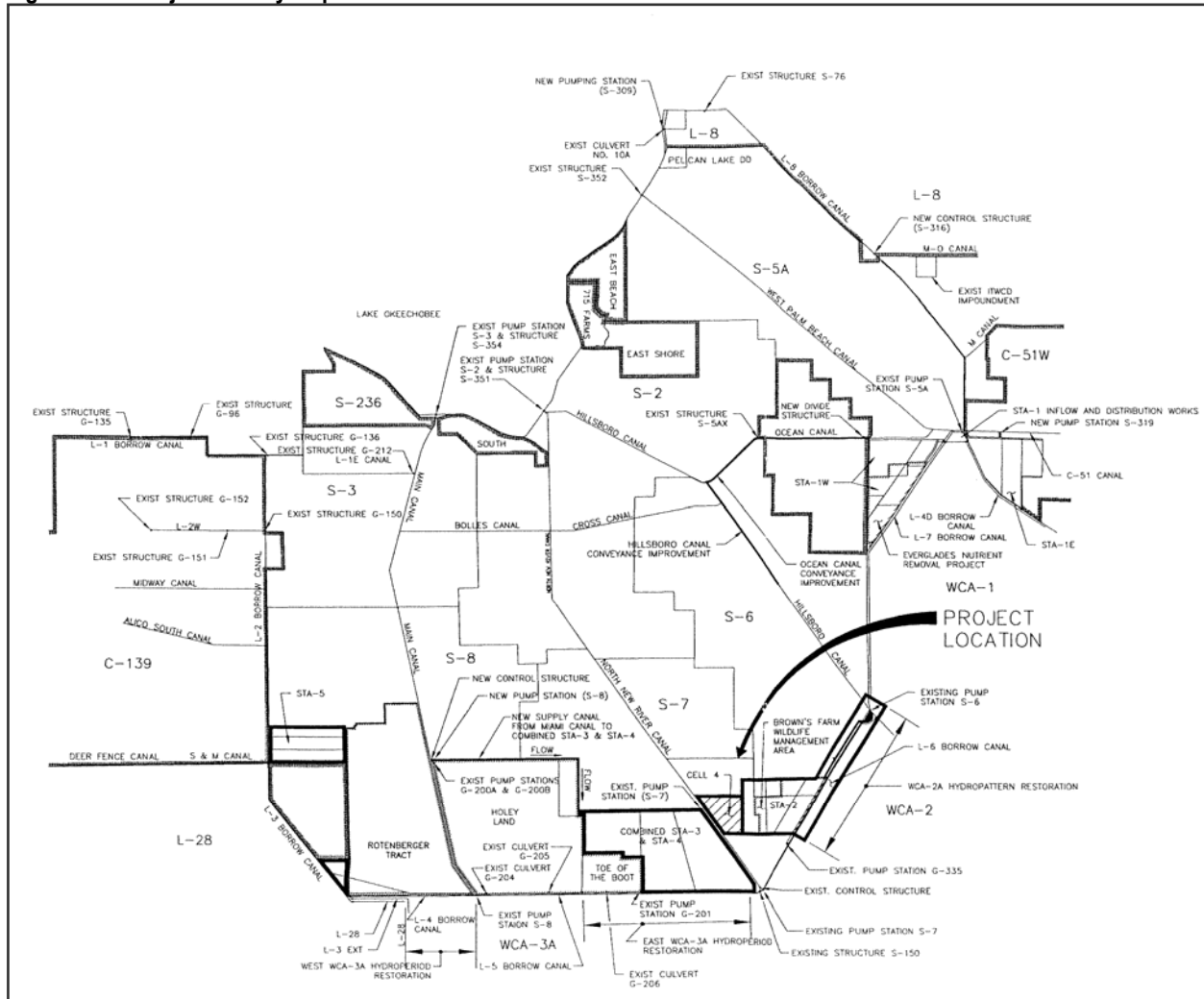
The Long-Term Plan for Achieving Water Quality Goals (October 2003) included recommendations for constructing interior dividing levees in Cells 1, 2 and 3 of STA 2, as well as conversion of the downstream portions of the newly divided cells from emergent to submerged aquatic vegetation (SAV). Soon after completion of the October 27, 2003 version of the Long-Term Plan, it was determined that Compartment B of the EAA Storage Reservoirs Project may not be needed for storage. As a result, the District submitted a revision to the Long-Term Plan to the FDEP to include an initial expansion of STA 2 with a new Cell 4 on Compartment B, as well as the postponement of the construction of the proposed interior levees in Cells 1, 2 and 3, and the associated vegetation conversion.

Development of Compartment B land into new treatment cells will occur in phases. As currently proposed, a new treatment cell (Cell 4) will be constructed on approximately 2,015 acres to the west and south of existing STA 2/Cell 3. The District has articulated its concept for development of STA 2/Cell 4 to the Florida Department of Environmental Protection (FDEP) in revisions to the October 2003 Long Term Plan, dated November 2004. These revisions to the Long Term Plan form the basis of the District's pending application to the FDEP for modification of the existing



EFA permit. As currently proposed, additional improvements to optimize operations in Cells 1 through 3 will not be made until flow through operation in Cell 4 has been established. Figure ES-1 is a vicinity map showing the general location of Compartment B land.

Figure ES-1. Project Vicinity Map





Project Objective

The primary objective of the STA 2/Cell 4 Expansion Project is to provide additional treatment capacity for the existing STA and as a result, to improve water quality in the EPA. To accomplish this objective, Cell 4 must be flow capable by December 31, 2006, subject to factors outside the control of the District as described in the November 2004 Long-Term Plan. A secondary objective is to develop Cell 4 with maximum design and operational flexibility so that it can become an integral part of the overall plan for build-out of Compartment B with minimal additional work.

Site Conditions

The District has leased Compartment B land to private corporations for agricultural operations. The land is divided into three components: the Woerner South Farm 2 property in the north (approximately 4,750 acres), the Carroll property in the center (1,233 acres), and the Okeelanta property in the south (approximately 3,600 acres). The Woerner property, also referred to as the North Build-Out Area, is an active sod farm. The lease on this property expires in February 2007. The Carroll property is a former sod farm that has not been active for several years. The Okeelanta property, also referred to as the South Build-Out Area, was an active sugarcane farm until last year. Control of this property was regained by the District in February 2005 as part of a land exchange with Okeelanta.

The STA 2/Cell 4 Expansion Project will be constructed on the entire 1,233 acres of the Carroll property and an estimated 782 acres of the Okeelanta property to the south. A 200-foot wide strip of land along the western side of Cell 3, north of Cell 4, which is currently part of the Woerner property, will also be needed to extend the existing STA 2 inflow canal south to Cell 4.

Physical Characteristics of the Cell 4 Site

Topography. Land surface elevations in Cell 4 generally range from about 8.0 to 9.5 feet NGVD, which is slightly less than the land surface elevations in existing Cell 3. There is no definitive gradient over the proposed Cell 4 site in either the north-south or east-west directions. However, the central portions of the site appear to be generally 0.5 to 1.0 feet lower than the east and west sides, suggesting that previous sod farming operations may have resulted in some soil loss in these areas. Elevations along the top of the existing NNRC East Levee generally range from about 17.5 to 18.5 feet NGVD, but in some places are as low as 15.5 feet NGVD.

Vegetative Cover. Most of Cell 4 will be constructed on the old Carroll property, which is overgrown with grass and underbrush that was established when the property was used for sod farming. The southern portion of Cell 4 will be constructed on the Okeelanta property. The property is still planted in sugarcane, but the crop is not being managed and will not be harvested.

Subsurface Conditions. Muck probe data collected during this project indicates that the depth of the surficial muck soils varies from 0 to more than 48 inches over the Cell 4 site with an average of about 14 inches. Data from standard penetration test (SPT) borings indicate that the muck soils are



underlain by generally strong limestone for an average depth of about 16 feet, followed by alternating layers of very well cemented and moderately well cemented silty sands and limestone.

Groundwater elevations across Compartment B land ranged from about +6.5 feet to about +12.5 feet NGVD at the time the subsurface investigations were performed. The water table was observed to range from about 2 to 3 feet above ground surface (standing water) to about 1.5 feet below ground surface at the drilling sites. For the purposes of permitting and design of the STA 2/Cell 4 Expansion Project, it can be assumed that the existing water table is at or very near ground surface.

Existing Site Features

Three predominant site features are present on the proposed Cell 4 site: existing farm roads and canals, an approximately 22.5-acre lake also referred to as the “fish farm”, and about 25 acres of periphyton stormwater treatment area (PSTA) field scale demonstration cells.

Farm Roads and Canals. There are three primary east-west farm roads across the proposed Cell 4 site. These are typically 10 to 12-foot wide dirt roads built up several feet above the elevation of the surrounding fields. Adjacent irrigation and drainage canals are typically excavated to a similar depth below grade to obtain the soil material to construct the road berms. Smaller ditches run north-south between the farm roads. The east-west farm roads will be degraded to within about 6 to 8 inches of ground surface as part of site preparation for Cell 4 construction. East-west farm canals will not be filled in. North-south ditches will be filled to reduce the potential for short-circuiting through the cell to the maximum extent possible.

Fish Farm. The “fish farm” is located in the southwest portion of the Cell 4 footprint. The fish farm is an old rock quarry that was converted into a fish nursery and is now abandoned. The area consists of a borrow pit, surrounded by a littoral zone and a perimeter levee. Soundings taken in the lake as part of this project suggest that the depth of the lake is approximately 15 to 25 feet below land surface at its deepest points. Seepage calculations performed as part of this project suggest that the lake will not act as a sink for water after Cell 4 has been placed into operation and that losses through the bottom of the lake will not be significant.

PSTA Cells. The PSTA Field Scale Cells are located in the northeastern portion of the proposed Cell 4 footprint, just south of the northern-most east-west farm road. The surface area of the PSTA cells is approximately 25 acres, comprised of four 5-acre cells with interior spreader and collector canals, inflow and outflow control structures, inflow and outflow canals and associated levees. The elevations of the levees are at approximately 13.5 feet NGVD with side slopes of 2:1. There is a borrow area remnant from the construction of the project located to the west of the PSTA cells.

Environmental Considerations

Environmental surveys on Compartment B land were conducted by the U.S. Fish and Wildlife Service (USFWS) when the land was still part of the EAA Reservoir Project. The results of those



surveys were published in a report dated November 2003. The principal findings relevant to the STA 2/Cell 4 Expansion Project that were documented in the report are as follows:

1. The Cultural Resources Survey did not identify any pre-historic or historic resources of significance on Compartment B land.
2. A total of 77 acres of jurisdictional wetlands were identified on Compartment B land. The most notable area delineated in the Cell 4 site was an approximately 10-acre littoral zone (shore area) around the "fish farm". This area was designed as a Category 1 wetland.
3. Native habitat for fish and wildlife does not comprise a significant amount of the EAA as the alteration of the landscape for agricultural uses has resulted in the removal of nearly all previously occurring native vegetation.
4. Eleven federally listed threatened and endangered species may potentially exist in the EAA. However, no specific references to Compartment B lands were made in the report.

Regulatory Requirements

A number of construction and operational permits will be required for the STA 2/Cell 4 Expansion Project. These include the following:

1. A modification to the existing Clean Water Act Section 404 Dredge and Fill Permit for the Everglades Construction Project (ECP) from the USACE;
2. Modification of the District's existing EFA Permit for STA 2 from the FDEP for construction, operation and maintenance of the ECP;
3. A National Pollutant Discharge Elimination System (NPDES) operations permit from FDEP for the expanded STA;
4. A modification of the District's existing individual consumptive use permit from FDEP for dewatering during construction; and
5. Local environmental and building permits from Palm Beach County.

The District is assuming the lead role in preparing applications and acquiring the necessary 404 and EFA Permits. The BC Team will support the regulatory processes by providing the technical information needed to obtain permit authorization. Delineation of responsibilities for other regulatory authorizations (i.e. local permitting requirements) is currently being reviewed. By far the most import permitting activity to the overall success of the STA 2/ Cell 4 Expansion Project is the timely issuance of a 404 Permit by the USACE. This permitting process is critical because construction cannot take place in any area determined to be a jurisdictional wetland until the 404 Permit is issued. The District submitted its application to the USACE for this permit in November



2004. The current target date for issuance of the 404 Permit is August 2005. However, if this schedule is delayed significantly, and the start of construction is held up as a result, it may not be possible to have Cell 4 substantially complete and in operation by December 31, 2006. The possibility of regulatory and other factors affecting the completion date was contemplated in the November 2004 Long-Term Plan.

Overview of Cell 4 Improvements

The purpose of the STA 2/Cell 4 Expansion Project is not to increase the flow capacity of the STA, but rather to improve water quality in discharges from the STA. Inflows to the STA will continue to be conveyed through the existing S-6 pumping station and inflow canal. Outflows will continue to be conveyed to the G-335 pumping station for discharge into WCA 2A. Because no additional peak flows will be accommodated, Cell 4 is being designed hydraulically to replicate the performance of Cell 3. This will allow the full STA design flow to be accommodated with any of the three existing treatment cells out of service.

The primary infrastructure improvements required for implementation of Cell 4 are shown on Figure C3 and include the following:

1. Upgrade a portion of the existing seepage canal along the northwest section of Cell 3 to serve as a portion of the inflow canal to Cell 4. Connect the new inflow (existing seepage) canal to the existing inflow canal at the west end of existing Cell 3 through the existing G-337A seepage pump station and plug the existing seepage canal upstream of this connection.
2. Remove the self cleaning trash screens, submersible pumps, and pump mount collars from the existing G-337A seepage pump station. Install motorized slide gates on the four pump inlet openings (40 inch x 80 inch) to control flow into the Cell 4 inflow canal.
3. Construct new inflow canal, six inflow structures, spreader canal, and associated levees along the north side of Cell 4. Permanent seepage management on the north side of Cell 4 will not be required. Temporary control to protect agricultural operations on the Woerner property will be accomplished using existing farm ditches and supplemental pumps. Agricultural operations are expected to cease a few months after startup with the eventual conversion of the area into additional STA.
4. Construct an interior levee along the east side of Cell 4 by utilizing the material from farm road degrading and from the collection and discharge canal excavations. Constructing an interior levee and allowing the existing seepage canal to remain provides the operating flexibility to convey inflow water from the S-6 pumping station to the South Build-Out Area or treated water from the North Build-Out Area to a discharge point in the south without affecting future operations in Cell 4.



5. Adjust the elevation of the existing NNRC East Levee to meet Cell 4 design requirements and to provide a uniform grade along the west side of Cell 4. As much as 3 or 3.5 feet of additional height will be needed at some points along the levee.
6. Construct a new collection canal, discharge water control structure, and perimeter levee on the south side of Cell 4. Note that seepage management on the south side of STA 2 will not be required as agricultural operations to the south have ceased with eventual conversion of the area into additional STA.
7. Upgrade the existing seepage canal south of Cells 2 and 3 to serve as an extension of the Cell 4 discharge canal and connect it to the existing STA 2 discharge canal downstream of the G-332 and G-334 structures. This connection will involve close coordination with Florida Power & Light (FP&L) because construction will occur within the easement for one of FP&L's 500 KW transmission lines and very close to an existing tower.

In addition to the constructed improvements required for Cell 4, the Operating Plan for STA 2 as a whole will require review and possible revision as a result of the project. Because the elevation of Cell 4 land is somewhat lower than the elevation of land in Cells 1 through 3, and because Cell 4 will be farthest away from the G-335 pumping station, it may be necessary to maintain lower stages in the canal to this pump station than is now the case to allow Cell 4 to discharge by gravity. This in turn may impact how Cells 1 through 3 are operated after Cell 4 comes on-line.

Design Development for Cell 4 Improvements

Modeling

Hydraulic evaluations were conducted to verify the sizing of the STA 2/Cell 4 inflow and outflow canal cross sections, establish diameter and invert elevations of culverts, identify crest elevations of weir control structures, establish levee heights and to determine the design of the internal works of the Cell.

The modeling was conducted for Cell 4 under three flow scenarios as defined in the scope of work:

- Low flow - 200 cfs (steady-state)
- Design flow - 1011 cfs (steady-state)
- Probable Maximum Storm (PMS)— 47.2 inches of rainfall over 24 hours plus 639 cfs of inflow to Cell 4 (replication of Cell 3 inflow for this scenario).

HEC-RAS version 3.1.2, developed by the U.S. Army Corps of Engineers (USACE), was used to conduct the analyses associated with sizing the canals, culverts and control structures for STA 2/Cell 4 and to establish initial conditions for the FESWMS and CHAN models. The steady flow component of HEC-RAS was used for these analyses. Results indicate sufficient hydraulic gradient



exists for Cell 4 to operate under gravity conditions for the low flow and design flow scenarios provided that G-335 is operated at 8.9 feet NGVD. All velocities simulated in the inflow and outflow canals were less than maximum allowable design velocity of 2.5 feet per second.

FESWMS/FIO2DH version 3.2.0, developed by Dr. David Froehlich for the Federal Highway Administration was used to conduct the analysis associated with the internal works of Cell 4. Results indicate flows are generally evenly distributed throughout the cell and that District design criteria are generally met within the cell body.

CHAN version 2.03, developed by Ghioto & DeLoach, Aquarian Software, Inc., was used to conduct the analysis associated with establishing the levee heights for Cell 4. Simulations with CHAN were conducted in an unsteady-state one dimensional model. Results indicate the PMS simulations produced peak stages at the Cell 4 outlet structure of 15.14 feet NGVD. This value represents the base elevation to which additional friction loss, across the cell, wind setup and wave run-up were added to obtain the design levee crown elevation

The results of the wave and wind analyses indicate that the levees need to be established for the project at a minimum of 18.7 feet NGVD at the north end of the cell and 18.1 feet NGVD at the south end of the cell.

Modeling of the treatment performance of Cells 1 through 4 for STA 2 was conducted using the April 2002 version of the Dynamic Model for Stormwater Treatment Areas (DMSTA) to evaluate the performance of total phosphorus (TP) reduction over the STA. Cells 1 through 3 were modeled as they currently exist. The proposed interior levees as described in the Long Term Plan for Achieving Water Quality Goals, were not accounted for in the DMSTA simulations. Due to the scientific uncertainty associated with the modeling of STA performance, the analyses presented in the BODR incorporate the use of multiple calibration data sets and a range of flows to help address the performance uncertainties.

The results of the DMSTA simulations, based on the adjusted baseline input data set (31-year simulated flow and TP loads), estimate STA 2 outflow TP concentrations ranging from 10-12 ppb for the geometric mean and 13-15 ppb for the flow-weighted mean with incorporation of Cell 4. The lower end of the ranges is associated with the SAV_C4 data set; whereas, the higher end of the ranges is associated with the STA2_3 data set. It should be noted that the simulations conducted with the adjusted baseline input series and the SAV_C4 produced warning messages that the outflow concentrations from the cells were lower than contained in the SAV_C4 calibration data set. The simulations conducted with the STA2_3 data set did not produce any warning messages. The warning messages produced do not necessarily mean that predicted outflow concentrations will not occur. The warning messages reflect that there is scientific uncertainty related to the predicted performance of the STA.

Simulations in DMSTA were also conducted for an increase of flow to STA 2. The inflows in the adjusted baseline input series were increased by 25 percent, and DMSTA simulations were conducted with the SAV_C4 and STA2_3 data sets. Results of the simulations estimate STA 2



outflow TP concentrations ranging from 12-15 ppb for the geometric mean and 15-18 ppb for the flow-weighted mean with incorporation of Cell 4 and a 25 percent increase of flows to STA 2. The simulations conducted with the increased inflows to STA 2 for the SAV_C4 and STA2_3 data sets did not produce any warning messages.

Conceptual Design of Project Elements

The primary project elements to be constructed as part of Cell 4 include perimeter and interior levees; inflow, outflow, spreader and seepage canals; inlet and outlet water control structures; and conversion of the G-337A pumping station to a water control structure in the Cell 4 inflow canal.

Typical Levee Design. Levees will be constructed to District design standards, including a top width of 14 feet and 3 horizontal to 1 vertical (3H:1V) side slopes. Levee construction material will generally come from the excavation of adjacent canals. Approximately two feet of organic muck soil lies over hard limestone cap rock. The rock is sufficiently hard that it will typically require blasting to break it up. Generally, levees will be constructed on top of the existing muck layer. Leaving the muck in place helps minimize seepage through the levee section.

Horizontal benches at existing grade level will be left between the toe of slope of levees and the top of slope of canal cuts. The benches will be approximately 20 feet wide. The benches aid material excavation and placement during construction, improve slope stability of the overall levee-canal section, and provide heavy equipment access for future canal dredging or levee maintenance activities by the District

Levee height was established using criteria consistent with the previous design of STA 2. Based on this analysis, preliminary levee height has been established at elevation 19.0 feet NGVD, which is consistent with existing elevations along the west and south exterior levees of Cell 3.

Typical Canal Design. Canals will be constructed to District design standards, including 2H:1V side slopes in rock cut and 3H:1V side slopes in muck areas to improve slope stability. Canal size was generally determined by earthwork balance calculations to provide sufficient borrow material to construct the associated levees. As a result, the canals are typically larger than necessary for conveyance of design flows.

G-337A Pumping Station Improvements. Cell 4 will receive water from an extension of the existing inflow canal. To allow this to occur, the G-337A structure will be converted to a water control structure. This will be accomplished by removing the self cleaning trash racks, removing the submersible pumps and mounting collars from the bulkhead wall, and installing actuated slide gates over the four pump inlet openings. Sufficient power and telemetry systems already exist at the pumping station for installation of the gates.

Hydraulic modeling indicates that the gated openings are of sufficient size to pass the project design flows without creating excessive losses or flow restrictions. Modeling also indicates that excess head may exist in the inflow canal under normal conditions since Cell 4 is lower in elevation than Cells 1



through 3; therefore, stage reduction in the inflow canal extension could be achieved at G-337A allowing the inflow culverts to Cell 4 to operate more passively. Utilizing the structure in this fashion would also create a positive shutoff point in the Cell 4 inflow canal.

Cell 4 Inflow Structures. Water will enter Cell 4 through a series of six water control structures. These structures will be 66-inch diameter, precast, reinforced concrete pipe culverts, with concrete headwalls at both the inlet and outlet ends. The locations of the culverts will be unevenly distributed, based on hydraulic modeling, to provide uniform flow distribution across the width of Cell 4. The inlet end of each culvert will be equipped with an actuated slide gate to provide flow control and positive shutoff to the cell. Inlet inverts will be set at elevation 2.25 feet NGVD so that the culverts will always operate fully submerged.

The design of the culverts will be in accordance with District standard design details. The slide gates on the inlet end will be equipped with motorized actuators. Power will be provided by a new service from U.S. Highway 27 that will be run across the NNRC and then overhead on poles from west to east along the inflow canal levee. Telemetry will be provided at each location in accordance with District standards for gate position indication and remote operation of the gates. Electronic water level monitoring gauges will be placed in stilling wells approximately 100 feet away from the upstream and downstream ends of each culvert in the inflow and spreader canals. The gauges will also be equipped with telemetry for remote monitoring consistent with the existing STA 2 system.

Cell 4 Outflow Structure. A single, sharp crested weir structure located in the southeast corner of Cell 4 will control outflow from the cell. This structure will consist of ten, 20-foot long bays, separated by piers, and built on top of a cast-in-place concrete gravity wall. Total weir length will be 200 feet. A Cipolletti shaped trapezoidal weir has been selected for this application because, when built to Bureau of Reclamation standards, they provide the highest degree of measurement accuracy. The weir crest is set at 9.65 feet NGVD. The weir is designed to maintain a water level of 1.25-1.5 feet in the cell (just upstream of the outflow structure) under low flow conditions, pass the maximum design flow (1011cfs) while keeping water depths in the cell under 4.5 feet, and provide a no flow dry-out protection depth of approximately one foot in the cell.

The energy of the water flowing over the weir bays will be dissipated in a deep pool downstream of the structure. This same pool forms the headwaters of four 8-foot by 8-foot reinforced concrete box culverts carrying outflows under the east levee into the discharge canal. The invert of these culverts has been set at -2.5 feet NGVD to maintain a minimum submergence of half the culvert rise over the full range of operating scenarios. Needle beams will be used for cell isolation.

Project Implementation Plan

Construction Schedule

Implementation of the Cell 4 expansion of STA 2 is a part of the overall plan by the District to improve water quality in discharges to the EPA. The project objective is to have Cell 4 operationally



capable to accept flows by December 31, 2006. Construction timeframes necessary to achieve this goal are estimated to be greater than twelve months. Sufficient time may not be available to complete the Basis of Design process, complete detailed design, bid and procure a construction contract, and execute construction in a conventional manner under a single contract to achieve this goal.

An alternative approach recommended by the project team is to accomplish construction under multiple contracts. Significant preparation of the Cell 4 site will be required to prepare it for construction of the main components and for establishment of SAV. The schedule presents the approach of preparing Site Preparation Contracts upon completion of the BODR phase simultaneously with the development of the detailed design. Site preparation activities could begin as early as July 2005.

The first anticipated contract would provide for demolition of existing farm facilities including old drainage pump stations, abandoned farm equipment, removal of drainage culverts from the NNRC levee, and removal of water control structures associated with the PSTA test cell. This work can proceed without obtaining the Section 404 permit and, therefore, could begin as soon as contract documents are prepared.

The second anticipated site preparation contract would provide for degrading of farm roads, filling of north/south ditches and canals and removal of the fish farm and PSTA cell levees will run from August 2005 to October 2005.

Completion of the site preparation work will be followed by construction of the principal infrastructure improvements including the canals, levees, and water control structures. These improvements are expected to be constructed under a single contract developed during the detailed design phase. It is anticipated that approximately twelve months will be required to achieve flow capable status in Cell 4; therefore, construction must begin no later than January 2006.

Opinion of Probable Cost

An Opinion of Probable Construction Cost for the Cell 4 expansion presented in this BODR was developed in accordance with Acceler8 Program guidance provided by the District. The total estimated cost of construction, including a 30% construction contingency, for the Cell 4 project is \$14,288,019.

Preliminary Operations Plan

Cell 4 will be supplied by water from the existing STA 2 inflow canal. Water to the cell will be directed through the converted G-337A water control structure where primary flow and stage control can be monitored and adjusted by the District. Inflow to the cell will be through six water control structures along the north control levee. Two pair of level indicating transmitters (LIT) located between the first and second and the fifth and sixth inflow structures will provide real time water surface elevations on both the supply and discharge pools. The gates will be capable of both



local and remote operation to any position from the District's central control room. The culverts will be totally submerged at all flow ranges. Water will be sampled at both the inflow canal and at the cell discharge. Needle beams will be used for cell isolation. The needle beams will be placed and removed by truck mounted crane and a lifting beam. The needle beams will be stored in a storage rack provided for this purpose.

The cell discharge will be controlled and measured by means of a weir located upstream of the discharge outflow culverts located at the southeast corner of Cell 4. This shall consist of four 8 feet x 8 feet box culverts with dewatering bulkhead slots on the upstream end to receive stop logs for positive cell isolation.

LIT's will be installed upstream and downstream of the weir to measure flow over the weir crest. The water level in the discharge canal shall be maintained at or below the desired Cell 4 operation level by the G-335 pumping station. This may require that the water level in the existing discharge canal be maintained at levels lower than historical operation of the current STA 2 system to avoid backflooding of Cell 4. Additional operational impacts may be seen at the G-334 and G-332 structures to maintain proper operation of Cells 2 and 3 as a result. The Cell 4 design flow will be conveyed through the system if the water stage at the G-335 pumping station is maintained at 8.9 feet NGVD in accordance with the current operations plan.



1. Introduction

This Basis of Design Report (BODR) documents work performed by the Brown and Caldwell consultant team (BC Team) for the South Florida Water Management District (District) related to the Cell 4 expansion of Stormwater Treatment Area 2 (STA 2/Cell 4 Expansion Project). The STA 2/Cell 4 Expansion Project is part of the program for Everglades restoration presented in the Revised Part 2 of the Long Term Plan for Achieving water Quality Goals and is being completed on a fast-track basis under the District's Acceler8 Program.

1.1 Background

The existing STA 2 is a 6,430-acre constructed wetland treatment system located in southern Palm Beach County between the North New River Canal (NNRC) and Water Conservation Area (WCA) 2A. STA 2 is presently divided into three treatment cells which operate in parallel. Inflow water is conveyed to the STA through an inflow canal from the S-6 pumping station and G-328 agricultural pumping station. Treated water is discharged to WCA 2A through the G-335 pumping station. The S-6 and G-328 pumping stations are designed to deliver a maximum flow of 3,370 cubic feet per second (cfs), and a maximum flow capacity of 3,040 cfs at G-335.

The original design of STA 2 was based on achieving a long-term annual average total phosphorus (TP) concentration of 50 parts per billion (ppb) in the Everglades Protection Area (EPA). Operational enhancements have resulted in TP concentrations in discharges from STA 2 approaching 20 ppb in recent years. Although the existing STA has exceeded the original design expectations, the District recognized that additional improvements may be needed to consistently meet the 10 ppb phosphorus criterion established in Rule 62-302.540 F.A.C.. The District's "Long Term Plan for Achieving Water Quality Goals" (October 2003) proposed continued conversion from emergent vegetation to submerged aquatic vegetation (SAV) and construction of internal canals and levees within the existing three treatment cells to improve overall treatment performance. However, it was pointed out in the Long Term Plan that these improvements, by themselves, may not be sufficient over the long term. Additional treatment area would improve the performance of STA 2 in reducing phosphorus discharges to the EPA.

Approximately 9,590 acres of District-owned land, located between STA 2 and the NNRC to the west, were originally designated as Compartment B of the Everglades Agricultural Area (EAA) Reservoir Project. Subsequent analyses, however, demonstrated that the water storage objectives of the EAA Reservoir could be achieved without Compartment B land, making it available for use by the District. Recognizing these additional lands would greatly increase the treatment area of STA 2, the District has moved forward with a conceptual plan for expanding STA 2 onto Compartment B land.



Figure G1 is a vicinity map showing the general location of Compartment B land in relation to STA 2 and the surrounding vicinity. Although owned by the District, the land has been leased to private companies for agricultural operations. A total of 1,233 acres immediately west of STA 2, known as the Carroll property, were used for growing sod. The lease on this land has expired and it is now in control of the District. Approximately 4,275 acres to the north, known as the Woerner South Farm 2 property, are currently being managed as an active sod farm. The lease on this land will not expire until February 2007. Approximately 3,600 acres to the south, known as the Okeelanta property, was planted in sugar cane in years past, but has been inactive in recent years. In February 2005, access to the property was acquired by the District as part of a land swap agreement with Okeelanta.

Because only a portion of the total land area comprising Compartment B is currently available, and because plans for use of the property are still evolving, development of new treatment cells will occur in phases. As currently proposed, a new treatment cell (Cell 4) will be constructed on the Carroll property and a portion of the Okeelanta property by December 2006. The entire Carroll property will be used, as well as 782 acres of the Okeelanta property, including a 500-foot strip along the southern edge of STA 2/Cell 3. The total land area comprising Cell 4, as currently proposed, is approximately 2,015 acres.

Build-out of the remainder of Compartment B is scheduled for completion by 2009. The District is currently conducting a regional feasibility study to determine how Compartment B land can best be used to improve the operational flexibility and performance of the regional water quality treatment system. When that feasibility study is completed later this year, a detailed plan for build-out of Compartment B will be developed. Cell 4 is being planned for maximum design and operational flexibility to reduce conflicts with the long-term plan that is ultimately selected for build-out of Compartment B.

The District has articulated its concept for development of STA 2/Cell 4 to the Florida Department of Environmental Protection (FDEP) in revisions to the October 2003 Long Term Plan, dated November 2004. The FDEP approved the proposed modification of the LTP in December 2004.

1.2 Project Objective

The primary objective of the STA 2/Cell 4 Expansion Project is to provide additional treatment capacity for the existing STA and as a result, to improve water quality in the EPA. To accomplish this objective, Cell 4 construction must flow capable by December 31, 2006, subject to factors outside the control of the District as described in the November 2004 Long-Term Plan. A secondary objective is to develop Cell 4 with maximum design and operational flexibility so that it can become an integral part of the overall plan for build-out of Compartment B with minimal additional work.



1.3 Project Description

The purpose of the STA 2/Cell 4 Expansion Project is not to increase the flow capacity of the STA, but rather to improve water quality discharges from the STA. Inflows to the STA will continue to be conveyed through the existing S-6 and G-328 pumping stations and inflow canal. Outflows will continue to be conveyed to the G-335 pumping station for discharge into WCA 2A. Because no additional peak flows will be accommodated, Cell 4 is being designed hydraulically to replicate the performance of Cell 3. This will allow the full STA design flow (3,370 cfs capacity at the S-6 and G-328 pumping stations) to be accommodated with any of the three existing treatment cells out of service.

The layout of proposed Cell 4 improvements is illustrated on Figure C3. Principal construction elements of the project, as currently proposed, include the following:

1. Upgrade a portion of the existing seepage canal along the northwest section of Cell 3 to serve as a portion of the inflow canal to Cell 4. Connect the new inflow (existing seepage) canal to the existing inflow canal at the west end of existing Cell 3 through the existing G-337A seepage pump station and plug the existing seepage canal upstream of this connection.
2. Remove the self cleaning trash screens, submersible pumps, and pump mount collars from the existing G-337A seepage pump station. Install motor operated slide gates on the four pump inlet openings (40 inch x 80 inch) to control flow into the Cell 4 inflow canal.
3. Construct new inflow canal, six inflow structures, spreader canal, and associated levees along the north side of Cell 4. Permanent seepage management on the north side of Cell 4 will not be required. Temporary control to protect agricultural operations on the Woerner property will be accomplished using existing farm ditches and supplemental pumps. Agricultural operations are expected to cease a few months after startup with the eventual conversion of the area into additional STA.
4. Construct an interior levee along the east side of Cell 4 by enlarging the existing seepage canal on the west side of Cell 3. Constructing an interior levee and allowing the existing seepage canal to remain provides the operating flexibility to convey inflow water from the S-6 and G-328 pumping stations to the South Build-Out Area or treated water from the North Build-Out Area to a discharge point in the south without affecting future operations in Cell 4.
5. Adjust the elevation of the existing NNRC East Levee to meet Cell 4 design requirements and to provide a uniform grade along the west side of Cell 4. As much as 3 or 3.5 feet of additional height will be needed at some points along the levee.
6. Construct a new collection canal, discharge water control structure, and perimeter levee on the south side of Cell 4. Note that seepage management on the south side of STA 2 will not



be required as agricultural operations to the south have ceased with eventual conversion of the area into additional STA.

7. Upgrade the existing seepage canal south of Cells 2 and 3 to serve as an extension of the Cell 4 discharge canal and connect it to the existing STA 2 discharge canal downstream of the G-332 and G-334 structures. This connection will involve close coordination with Florida Power & Light (FP&L) because construction will occur within the easement for one of FP&L's 500 KW transmission lines and very close to an existing tower.

In addition to the constructed improvements required for Cell 4, the Operating Plan for STA 2 as a whole will require review and possible revision as a result of the project. Because the elevation of Cell 4 land is somewhat lower than the elevation of land in Cells 1-3, and because Cell 4 will be farthest away from the G-335 pumping station, it may be necessary to maintain lower stages in the discharge canal than is now the case to allow Cell 4 to discharge by gravity.

1.4 Purpose and Scope of the Basis of Design Report

The purpose of this BODR is to document the conceptual design of the STA 2/Cell 4 Expansion Project with sufficient detail and technical merits of the proposed design given the stated project objectives. Accordingly, this BODR includes information on existing site conditions and the results of studies and investigations performed in developing design criteria and conceptual designs for the various project elements.

Prior to work beginning on the BODR, two preliminary Work Orders were issued by the District to the BC Team related to the STA 2/Cell 4 Expansion Project. The scope of the first Work Order involved a review of the District's proposed concept for the STA 2/Cell 4 Expansion Project. The work included (1) a compilation of relevant data and reports available from the District, (2) preliminary surveying and geotechnical work required to perform the review of the District's plan, and (3) development and evaluation of alternative concepts to use as a means of comparison to the District's approach. A technical memorandum, documenting the BC Team's evaluation of the District's conceptual plan for expansion of STA 2 into Cell 4, is included in Appendix A of this report.

The second Work Order included comprehensive surveying and geotechnical investigations of the Cell 4 area that will be needed to support design. A surveying report, prepared by Weidener Surveying & Mapping, Inc, is included in Appendix C. A geotechnical report, prepared by RADISE International, Inc., is included in Appendix D.

The Scope of Work for this BODR was developed to build upon the results of the preliminary work completed by the BC Team in the first two Work Orders. Primary work elements associated with developing the BODR were as follows:



1. Project management and coordination activities with District staff, including attendance at meetings to establish strategies for permitting and other aspects of project implementation to satisfy the project objectives.
2. Definition of the final layout of Cell 4.
3. Hydraulic and hydrologic modeling of Cell 4 under low flow, design flow and probable maximum storm (PMS) conditions, including hydraulic design of the inflow and outflow control structures and canals, two-dimensional modeling of the internal works, and wind setup and wave run-up calculations to determine maximum levee height.
4. Water quality modeling using the Dynamic Model for Stormwater Treatment Areas (DMSTA) to determine the expected phosphorus reduction performance of STA 2 with the addition of Cell 4.
5. Civil engineering design, including the degrading of existing site features, where applicable, and calculation of earthwork quantities to generally balance cuts and fills during construction.
6. Geotechnical engineering design, including analyses for settlement, slope stability and seepage, to define typical canal and levee cross-sections, consistent with District standards.
7. Development of an implementation plan for the project, including construction strategies for meeting completion deadlines, concepts for recreational benefits, site access and security considerations, and possible modifications to the District's Operations Plan for STA 2.
8. Presentation of the results of the BODR at briefings to the District, the Water Resources Advisory Committee (WRAC) and other project stakeholders.

In summary, the BODR is intended to provide a comprehensive discussion of the conceptual design of STA 2/Cell 4, including the necessary site information, model simulations and engineering calculations to support the proposed design.



2. Site Conditions

2.1 Environmental Setting

The following paragraphs provide summary information on the general environmental setting surrounding the project site.

2.1.1 Climate

The climate of south Florida is generally characterized as subtropical. Temperatures generally range from about 35 to 100 degrees Fahrenheit, although lower and higher extremes have been recorded. Recorded annual rainfall in south Florida has varied from 37 to 106 inches. Of the 53 inches of rain that south Florida receives annually on average, 75 percent falls during the wet season months of May through October. During this period, highly localized storms occur almost daily. Tropical storms and hurricanes also provide major contributions to wet season rainfall in some years, as evidenced by the four storms that affected south Florida during the summer of 2004. During the dry season, rainfall is governed by large scale weather fronts that pass through the region. Evapotranspiration rates are high in south Florida. On a long-term, average annual basis, total evapotranspiration approximates annual rainfall.

2.1.2 Regional Geology

The Everglades is located within a geological depression that runs south from Lake Okeechobee through the center of south Florida to Florida Bay. The Everglades ecosystem, primarily a sawgrass marsh with hammocks of willow, myrtle and bay tree, lies between two areas of slightly higher elevation on the east and west. To the west lies exposed Pliocene limestone of the Big Cypress Ridge. To the east lies late Pleistocene quartz sand and oolitic limestone of the Atlantic Coastal Ridge. The bedrock floor of the Everglades is essentially flat and overlain by a fairly uniform mantle of freshwater peat and muck from the Holocene epoch. These surficial organic soils fill the geologic depression between the two ridges. The thickness of these soils ranges from over ten feet in the northern Everglades, where bedrock elevations are the lowest, to less than three feet in the southern Everglades.

In the 1970s, the U.S. Department of Agriculture, Soil Conservation Service (McCollum et. al., 1978) mapped the Everglades Agricultural Area (EAA) as part of a soil survey for Palm Beach County. Seven primary soil types were identified in the EAA as a result of that survey: Torrey muck, Terra Ceia muck, Pahokee muck, Lauderhill muck, Dania muck, Okeelanta muck and Okeechobee muck. The Terra Ceia and Pahokee series represent about 80 percent of the soils present in the EAA. Classification of these soils is largely based on soil properties and the depth to limestone bedrock. Terra Ceia and Okeechobee muck represent the deepest soils (more than 96 inches), followed by Pahokee muck (between 36 and 96 inches), Lauderhill muck (between 20 and 36 inches) and Dania muck (less than 20 inches).



2.1.3 Ground and Surface Water Hydrology

The regional ground and surface water hydrology of the EAA has been documented over the years in numerous studies and investigations by the District, the U.S. Army Corps of Engineers (USACE), the U.S. Geological Survey (USGS), and others. In 2004, the Water Management element of the Project Implementation Report (PIR) for the EAA Storage Reservoir Project was completed (SFWMD, USACE, Kimley Horn and Associates, Inc., Project Element H.6, June 2004). This report provides a comprehensive review of the hydrography of the EAA with emphasis on the movement of water through land designated for use in the EAA Storage Reservoir Project. This report includes the regional ground and surface water hydrology affecting Compartment B land and is available on the District's web site. No additional work specific to the ground and surface water hydrology of Compartment B land was performed as part of this project.

2.1.4 Seismic Environment

USGS earthquake hazard maps for the United States indicate that south Florida is in the lowest possible hazard category for earthquakes. Protection against earthquakes will not be a factor in the permitting and design of the STA 2/Cell 4 Expansion Project.

2.2 Site Characteristics

The following paragraphs provide information related to current site conditions and site features that must be considered in the permitting and design of the STA 2/Cell 4 Expansion Project.

2.2.1 Site Boundary

A boundary survey of the Compartment B land owned by the District has not been prepared. As part of the work performed for this Basis of Design Report (BODR), property descriptions from the 21 deeds comprising Compartment B land were mapped to determine if there are any areas in conflict with one another or if any areas thought to be part of Compartment B are actually not owned by the District. The results of that mapping effort suggest that, except for a few minor exceptions which need to be researched further, all of the land designated as Compartment B is accounted for in the deeds. The exceptions involve a few small areas where it is not clear from the deeds whether the land in question is included or not. One of these areas is in the northwest corner of the area designated for Cell 4 development (less than one acre). The others are located to the south of Cell 4 in the area that is designated for future Compartment B build-out.

The results of the preliminary property mapping suggest that a full boundary survey of Compartment B is needed, including the research to resolve the outstanding property ownership issues. For the Cell 4 project, it will be necessary to clearly define the property boundary separating the Woerner and Carroll properties to assure that the inflow canal and perimeter levee on the north side of Cell 4 is located properly. Additionally, it will be necessary to resolve the property ownership issue on the northwest corner of Cell 4. If the District does not presently hold title to this small piece of land, and cannot reasonably gain access to it by the time construction of Cell 4 must begin,



the land will need to be excluded from Cell 4 and integrated into the build-out of Compartment B as part of a future project.

2.2.2 Existing Site Topography

A limited amount of topographic data was compiled on the STA 2/Cell 4 site to facilitate hydraulic modeling and design of the internal works. For the most part, topographic data were collected along the alignment of the anticipated levee and canal alignments and the three existing east-west farm roads. Sections were surveyed every 1000 feet along the levee/canals and 1500 to 2000 feet along the roads, extending from the top of berm to the toe of slope and then for some distance (typically 25 feet) out into the fields on both sides of the road to approximate existing land surface elevations in the interior of the cell. Widely spaced (approximately 1300 foot spacing) ground shots were also collected through the middle of the old farm field areas for general topographic definition. The resultant topographic data provided a basis for constructing a digital terrain model for use in hydraulic models and preliminary earthwork calculations. Elevations were also collected along the top of the existing North New River Canal (NNRC) East Levee.

Land surface elevations in Cell 4 generally range from about 8.0 to 9.5 feet NGVD, which is slightly less than the land surface elevations shown on the design drawings for existing Cell 3. There is no definitive gradient over the proposed Cell 4 site in either the north-south or east-west directions. However, the central portions of the site appear to be generally 0.5 to 1.0 feet lower than the east and west sides, suggesting that previous sod farming operations may have resulted in some soil loss in these areas. Existing farm roads been built up several feet above adjacent land. Additional selected topographic data will need to be collected as part of 30 percent design development to confirm land surface elevations in several areas of the cell.

Elevations along the top of the existing NNRC East Levee generally range from about 17.5 to 18.5 feet NGVD, but in some places are as low as 15.5 feet NGVD. Assuming that the top elevation of perimeter levees around Cell 4 will ultimately set at about 19.0 feet NGVD, as much as 3.5 feet of additional height will need to be added to this levee in certain locations.

Existing site topography is illustrated on Figure C2 of this report. Copies of the Surveyor's Reports prepared by Weidener Surveying & Mapping, Inc., documenting the work performed and the data submitted to Brown and Caldwell and the District in support of this BODR, are included in Appendix B.

2.2.3 Vegetative Cover

A detailed vegetation survey over the Cell 4 site was not conducted as part of this project. Visual observations during site walkovers indicate that the majority of the old Carroll property is overgrown with grass and underbrush that were established during previous sod farm operations. This vegetation appears to range in height from about 3 feet to 6 feet over much of the western two-thirds of the Carroll property and may be somewhat higher in some places. In the eastern third of the Carroll property, particularly in the vicinity of the PSTA cells, the vegetation is not as high,



suggesting that this area may have been the last area to be harvested before farming operations ceased.

The southern portion of Cell 4, which will be developed on land previously farmed by Okeelanta, is abandoned sugarcane field. The cane was harvested in late 2003 or early 2004, but was not fertilized for another growing season.

2.2.4 Subsurface Conditions

A two-phase subsurface investigation program was conducted in support of this BODR. A combination of muck probes, standard penetration test (SPT) borings, rock cores and test pits were used, in combination with research from other projects, to characterize subsurface conditions in the proposed Cell 4 site. The geotechnical engineering report, prepared by RADISE, International, Inc., documenting the work performed and the data collected is included in Appendix C.

A total of 61 muck probe sites were investigated. Muck probe data indicates that the depth of the surficial muck soils varies from 0 to more than 48 inches over the site with an average of about 14 inches. The deepest depths of muck soils were generally found in the northeast portion of Cell 4 along the proposed inflow canal.

In situ and laboratory permeability test data for the peat soils in farmed areas ranged from 0.2 to 7.8 feet per day (fpd) with an average of 2.5 fpd. The permeability of peat soils in non-farmed areas was found to be considerably higher.

A total of twelve 25-foot deep and two 50-foot deep SPT borings were made in the Cell 4 site. The data collected from these borings indicates that moderately to strongly cemented limestone underlies the surficial muck soils. The boring logs showed generally strong limestone for a depth of 16 feet below the organic soil followed by alternating layers of very well cemented and moderately well cemented silty sands and limestone. The boring locations and boring logs are presented in the geotechnical report in Appendix C.

Groundwater elevations across the site at the time the subsurface investigations were performed ranged from about + 6.5 feet to about +12.5 feet NGVD. The water table was observed to range from about 2 to 2.5 feet above ground surface (standing water) to about 1.5 feet below ground surface at the drilling sites.

2.2.5 Environmental Conditions

A comprehensive environmental assessment of the lands originally proposed for the EAA Storage Reservoir Project was performed by the U.S. Fish and Wildlife Service in 2003 (USFWS, EAA Storage Reservoir Project – Phase 1, Existing Environmental Conditions, November 2003). A copy of this report is included in Appendix D of this BODR for reference. Compartment B land, including the properties to be developed initially as Cell 4, was included in the environmental surveys conducted at that time. Accordingly, no new environmental surveys on the proposed Cell 4



site were performed as part of this project. The primary findings of the 2003 USFWS report, as they relate to the permitting and design of the STA 2/Cell 4 Expansion Project, include the following:

1. The Cultural Resources Survey did not identify any pre-historic or historic resources of significance on Compartment B land.
2. A total of 77 acres of jurisdictional wetlands were identified on Compartment B land. The most notable area delineated in the Cell 4 site was an approximately 10-acre littoral zone (shore area) around the “fish farm”. This area was designed as a Category 1 wetland.
3. Native habitat for fish and wildlife does not comprise a significant amount of the EAA as the alteration of the landscape for agricultural uses has resulted in the removal of nearly all previously occurring native vegetation.
4. Eleven federally listed threatened and endangered species may potentially exist in the EAA. However, no specific references to Compartment B lands were made in the report.

Permitting is discussed in Section 4 of this BODR. Of particular importance is the USACE’s concurrence on wetlands delineation. A flyover is scheduled for late March 2005 to further establish wetland limits.

2.3 Existing Physical Site Features

There are a number of physical site features that will affect the design of the STA 2/Cell 4 Expansion Project. These include farm roads and canals, a 22.5-acre lake on the southwest portion of the site (fish farm), and PSTA cells on the east side of the site. The following paragraphs provide an overview of these physical site features.

2.3.1 Farm Roads and Canals

There are three primary east-west farm roads across the proposed Cell 4 site. These are typically 10 to 12-feet wide dirt roads built up several feet above the elevation of the surrounding fields. Adjacent irrigation and drainage canals are typically excavated to a similar depth below grade to obtain the soil material to construct the road berms. Smaller ditches run north-south between the farm roads. The east-west farm roads will be degraded to within about 6 to 8 inches of ground surface as part of site preparation for Cell 4 construction. East-west farm canals will not be filled in. North-south ditches will be filled to reduce the potential for short-circuiting through the cell to the maximum extent possible.

2.3.2 Fish Farm

A notable feature on the proposed Cell 4 site is an approximately 22.5-acre lake known as the “fish farm”. The fish farm is an old rock quarry that was converted into a fish nursery and is now abandoned. The area consists of a borrow pit, surrounded by a littoral zone and a perimeter levee.



Soundings taken in the lake as part of this project suggest that the depth of the lake is approximately 15 to 25 feet below land surface at its deepest points. Seepage calculations performed as part of this project suggest that the lake will not act as a sink for water after Cell 4 has been placed into operation and that losses through the bottom of the lake will not be significant. The results of this seepage analysis are documented in the geotechnical engineering report in Appendix C of this BODR.

2.3.3 PSTA Cells

The Periphyton Stormwater Treatment Area Field Scale Cells (PSTA cells) are located in the northeastern portion of the proposed Cell 4 footprint, just south of the northern-most east-west farm road. The surface area of the PSTA cells is approximately 25 acres, comprised of four 5-acre cells with interior spreader and collector canals, inflow and outflow control structures, inflow and outflow canals and associated levees. The elevations of the levees are at approximately 13.5 feet NGVD with side slopes of 2:1. There is a borrow area remnant from the construction of the project located to the west of the PSTA cells.



3. General Design Requirements

This section presents the general design requirements for the STA 2/Cell 4 Expansion Project. Information is presented regarding project limits, site datum, functional and operational requirements, conceptual alternatives evaluated, units of measurement for design, and applicable codes and standards.

3.1 Project Limits

The STA 2/Cell 4 Expansion Project is generally bounded on the east by the existing seepage canal on the west side of STA 2/Cell 3; on the north by an existing farm road separating the Woerner South Farm 2 property from the old Carroll property; on the west by the North New River Canal (NNRC) East Levee; and on the south by an east-west line running about 500 feet south of existing STA 2/Cell 3, starting at the (NNRC) East Levee and terminating just east of the G-332 and G-334 structures. These limits are illustrated on Figures C1 through C3 of this report.

On the east, a new levee will be constructed approximately 150 feet west of the centerline of the existing seepage canal on the west side of Cell 3 to form the eastern boundary of Cell 4. The resulting canal corridor between Cell 3 and Cell 4 will allow either inflow or outflow water to be conveyed from the north to the south, depending on the Compartment B build-out scenario that is ultimately selected, without impacting operations in Cell 4.

It should be noted that the U.S. Army Corps of Engineers (USACE) has not yet agreed to allow the NNRC East Levee to serve as the perimeter levee on the west side of Cell 4. If approval is not granted, a new perimeter levee, inboard of the existing NNRC East Levee, will need to be constructed and the project limits will need to be adjusted accordingly. If approval is granted as planned, the top elevation of the levee will need to be raised for consistency with levee elevations on other sides of the cell. This will result in adding as much as 3 to 3.5 feet of elevation to the top of the levee in some locations. Accordingly, the project limits on the west side of Cell 4 would extend across the full width of the NNRC East Levee.

A boundary survey was not prepared as part of the work performed for this Basis of Design Report (BODR).

3.2 Site Datum

Horizontal control for surveying work conducted at the site was based on the State Plane Coordinate System, Florida East Zone, North American Datum of 1983, Adjustment of 2003. Vertical control was based on the North American Vertical Datum of 1988 (NAVD 88). For design, however, the National Geodetic Vertical Datum of 1929 (NGVD 29) will be used to provide for consistency with previous designs. The offset to convert NAVD 88 elevations to NGVD 29 is approximately +1.46 feet, based on the nearest reference point to the project site. All topographic



survey data collected from the project site has been converted to NGVD 29 elevations for design. Additional information on survey controls and the site datum to be used for design is presented in the Surveyor's Report in Appendix B.

3.3 Functional and Operational Requirements

The primary purpose of the STA 2/Cell 4 Expansion Project is to provide additional treatment capacity for the existing STA and as a result, to improve water quality in the Everglades Protection Area. Based upon the demonstrated treatment performance achievable with different vegetation types, the District has determined that submerged aquatic vegetation (SAV) will be used in STA 2. SAV is currently being used in Cell 3 and plans are in place to convert portions of Cells 1 and 2 from emergent vegetation to SAV, dependent on construction of the proposed interior dividing levees, in the future as part of the District's Long Term Plan for Achieving Water Quality Goals (October 2003, revised November 2004). Accordingly, Cell 4 will also be designed for SAV.

On January 28, 2005, representatives of the BC Team met with Acceler8 Program staff and District engineering, operations and maintenance staff to discuss general design criteria for the Cell 4 expansion and the operational requirements and preferences for the project. The following summarizes the key points that were discussed at that meeting relative to the functional and operational requirements of the expanded STA 2.

1. STA 2 will not receive any additional peak flow after the Cell 4 expansion has been completed than it does presently. Hydraulically, Cell 4 should be designed to accommodate the same peak flow as Cell 3. This will allow the STA to function as it does now with any of the four cells out of service.
2. Low flow and design flow conditions should be based on inflows to Cell 4 of 200 cubic feet per second (cfs) and 1011 cfs, respectively.
3. Cell 4 will operate under gravity flow conditions, discharging through the G-335 pumping station with no additional inflow or outflow pumping required.
4. Levee height is to be based upon maximum operating water depth in the cell plus 3 feet or Probable Maximum Storm (PMS) conditions plus wind setup and wave run-up, whichever is greater. Since land elevations in Cell 4 are somewhat lower than in Cells 1 through 3, it is not necessary for the top elevation of the perimeter levees around Cell 4 to match the top elevation of levees around Cells 1 through 3 as long as the design criteria for determining levee height are satisfied.
5. All gated inflow and outflow control structures are to be designed with telemetry to allow for fully automated remote operation.
6. The width of the canal corridor to remain between Cells 3 and 4 for future use as an inflow or outflow canal should be calculated on the basis of providing hydraulic capacity of 0.5 cfs



- per acre of treatment area in the Woerner property or a cut/fill material balance whichever is greater.
7. Cell 4 will operate as a single treatment cell with no internal compartments. Farm canals oriented in the north-south direction should be filled to reduce short circuiting. Farm roads oriented in the east-west direction should be degraded to a height of 6 inches to 8 inches above existing grade to assist in preventing SAV washout during storm events. Farm canals oriented in an east-west direction should not be filled in.
 8. Since Cell 4 is being designed as an SAV cell, normal water depths need to be maintained between 15 and 18 inches above average floor elevation in the cell measured at the outlet of the cell. The minimum operational water depth in Cell 4 will be 0.5 feet. The maximum operational water depth can be 4.5 feet.
 9. The internal works of the cell should be designed to provide for uniform flow distribution with no stagnant zones. The maximum flow velocity should not exceed 0.1 feet per second (ft/sec). The maximum flow velocity in canals to and from Cell 4 should not exceed 2.5 ft/sec.
 10. Flow measurement will be determined by head differential across the inflow and outflow control structures. Stilling wells with water level gauges need to be provided upstream and downstream of the structures. No additional flow measuring devices need to be included in the design of water control structures themselves.
 11. Levees around the existing Fish Farm and PSTA Test Cells will be degraded and the features will be absorbed into Cell 4. No specific recreational benefits from these features are required in the design of Cell 4.
 12. Levee, canal and water control structure designs shall be to District standard, taking into account specific subsurface conditions that could require modification to those standards.

In addition to the specific functional and operational requirements noted above, the overarching requirement of the STA 2/Cell 4 Expansion Project is that the hydraulic design of Cell 4 must not adversely affect the ability of Cells 1 through 3 to perform as designed.

3.4 Conceptual Alternatives Evaluated

Prior to the initiation of work on the BODR, the BC Team reviewed the feasibility of the District's concept for initial development of Cell 4 and subsequent build-out of Compartment B. To perform this review, it was necessary to create and evaluate a number of other alternative concepts as a means of comparison. A total of four conceptual alternatives were defined and evaluated, including the District's plan. It was determined that the District's approach was sound, and that with a few refinements, would provide the desired flexibility for incorporating Cell 4 into a future build-out scenario for Compartment B with a minimum of additional work. The recommended plan derived



from the evaluation of conceptual alternatives was used as the starting point for design development in this BODR. The Technical Memorandum describing the work performed during the evaluation of alternatives is included in Appendix A of this report.

3.5 Units of Measurement for Design

Design documents for the STA 2/Cell 4 Expansion Project will be prepared using English units of measurement.

3.6 Applicable Codes and Standards

Codes and standards applicable to the design of the STA 2/Cell 4 Expansion Project include, but are not necessarily limited to, the following:

Civil Engineering Design

AASHTO	American Association of State Highway and Transportation Officials
ASTM	American Society of Testing Materials
ASCE	American Society of Civil Engineers
BLM	Bureau of Land Management design standards
FDOT	Florida Department of Transportation Design Standards and Standard Specifications for Road and Bridge Construction
SFWMD	South Florida Water Management District engineering design standards
USACE	U.S. Army Corps of Engineers EMs/TMs

Structural Design

ACI	American Concrete Institute
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ASTM	American Society of Testing Materials
AWS	American Welding Society
FBC	Florida Building Code
OSHA	Occupational Safety and Health Administration
USACE	U.S. Army Corps of Engineers EMs/TMs



Mechanical Equipment

ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing Materials
HI	Hydraulic Institute
NBS	National Bureau of Standards
NEC	National Electric Code
NEMA	National Electrical Manufacturer's Association
SFWMD	South Florida Water Management District
USACE	U.S. Army Corps of Engineers

Electrical Design

ANSI	American National Standards Institute
ASTM	American Society of Testing Materials
FBC	Florida Building Code
IEEE	Institute of Electrical and Electronic Engineers
ISA	Instrument Society of America
NEC	National Electric Code
NEMA	National Electrical Manufacturer's Association
NFPA	National Fire Protection Association
SFWMD	South Florida Water Management District
USACE	U.S. Army Corps of Engineers



4. Regulatory Considerations

Development of the STA 2/Cell 4 Expansion Project requires the review and approval of regulatory agencies at the federal, state and local level. A number of construction and operational permits are required. The District is assuming the lead role in preparing applications and acquiring the necessary Everglades Forever Act (EFA) and Clean Water Act permits. Delineation of responsibilities for other regulatory authorizations (i.e. local permitting requirements) is currently being reviewed. The BC Team is providing design and schedule information, and other technical documentation in support of the District's permitting activities. The following paragraphs summarize the regulatory agencies with jurisdiction over the project, the applicable regulations involved, and the permits that must be acquired before Cell 4 can be constructed and/or placed into operation.

4.1 Federal Regulatory Requirements

Because the STA 2/Cell 4 Expansion Project will be constructed on land outside the footprint of the existing Everglades Construction Project (ECP), which included STA 2 Cells 1 through 3, a Clean Water Act, Section 404 Dredge and Fill Permit (404 Permit) from the U.S. Army Corps of Engineers (USACE) will be required. The 404 permitting process is an extensive one, involving a number of federal review agencies, including the U.S. Fish and Wildlife Service, the U.S. Environmental Protection Agency, and the U.S. Department of the Interior. Because of the extensive environmental investigations typically required for a federal 404 Permit, the review and approval process can often take 12 to 18 months to complete. Fortunately, in this case, much of the environmental survey work for Compartment B land was completed when it was still part of the Everglades Agriculture Area (EAA) Storage Reservoir Project. Preconstruction surveys may be needed for species of concern with appropriate mitigation as required.

The District submitted a 404 Permit application to the USACE covering the STA 2/Cell 4 expansion in November 2004. A Request for Additional Information (RAI) from the USACE was received on February 18, 2005. As of the writing of this report, the District was in the process of preparing responses to the RAI. The District does not anticipate any significant problems with permitting of the STA 2/Cell 4 expansion, but acknowledges that issues related to the expansion of STA 5 may delay issuance of the 404 Permit. The current target date for issuance of the 404 Permit is August 2005.

A key element of the 404 permitting process is the determination of jurisdictional wetland limits in Cell 4 by the USACE. A flyover of Cell 4 occurred on March 24, 2005 to assess the aerial extent of jurisdictional wetlands on Compartment B land. It was determined that extensive areas within Cell 4 are considered jurisdictional wetlands. Certain early work activities such as demolition of structures, roads and buildings, removal of concrete building pads, debris removal and culvert removal will be allowed prior to permit issuance. USACE regulatory staff will make a determination whether any major clearing and grubbing will be allowed prior to permit modification issuance. Given the accelerated time schedule for completion of the STA 2/Cell 4 Expansion Project, being able to



begin site preparation activity prior to the primary construction contract will be important to having Cell 4 in place and operational by December 2006. Construction sequencing is discussed in greater detail in Section 8 of this report. If the 404 Permit modification is issued by August 2005 as planned, site preparation can begin in all areas of Cell 4 even if they are determined to be jurisdictional. However, if jurisdictional wetland areas in Cell 4 are extensive and if issuance of the 404 Permit is delayed, the inability to begin site preparation ahead of the primary construction contract could impact Cell 4 being substantially complete and operational by December 2006. Impacts to jurisdictional areas within Cell 4 have been mitigated by the District's purchase and management of approximately 61,000 acres of wetlands obtained pursuant to EFA mitigation requirements.

4.2 State of Florida Regulatory Requirements

The three primary State of Florida permits required for the STA 2/Cell 4 Expansion Project are (1) an EFA permit for the construction, operation and maintenance of Cell 4, (2) a National Pollutant Discharge Elimination System (NPDES) operations permit for the operation of the expanded facility, and (3) a consumptive use permit for dewatering during construction. A NPDES Generic Permit for the discharge of produced groundwater during dewatering operations will not be required from the Florida Department of Environmental Protection (FDEP) for this project unless there is an off-site discharge during construction. No such discharge is currently planned.

4.2.1 Everglades Forever Act Permit

In Chapter 373.4592 of the Florida Statutes, the Florida Legislature authorized FDEP to issue EFA permits to the District for projects that are part of the ECP. EFA permits are issued for a period of 5 years and cover the construction, operation and maintenance of ECP components. Since STA 2 is included in an existing EFA permit (FDEP Permit No. 0126704), the expansion into Cell 4 will be permitted by FDEP as a modification to that permit. Minimization of impacts to state jurisdictional wetland areas to the maximum extent practicable is specifically referenced in the existing permit.

In December 2004, the District submitted to FDEP the November 2004 revisions to the Long Term Plan documenting its approach for expansion of STA 2 onto Compartment B land. Additional supporting documentation on project implementation will be provided to the FDEP as it becomes available, beginning with this Basis of Design Report (BODR) when it is formally approved. The FDEP will also review the design, either at the 30 or 60 percent design completion level, as part of the "reasonable assurance" test for application completeness. It is likely that there will be no new permit-related monitoring requirements specific to Cell 4. However, the District will likely monitor treatment performance in Cell 4 for the purpose of operational control.

The EFA permit modification will be written such that there cannot be any discharge from Cell 4 until it passes net reduction tests as identified in the EFA permit. The net reduction for phosphorus shall be deemed to occur when the 4-week geometric mean total phosphorus water column



concentration from samples collected at the Cell 4 outflow structures is less than the 4-week geometric mean total phosphorus water column concentration collected at the S-6 pumping station.

The second net reductions test is for total mercury and methyl mercury. These reductions shall be deemed to have occurred when the water column concentrations for both total and methyl mercury at a chosen midpoint of Cell 4 are not significantly greater than the concentrations of the corresponding species at S-6. A discharge from Cell 4 into the existing outflow canal conveying water to the G-335 pumping station cannot be made until Cell 4 passes these tests. The Cell 4 outflow gates will be required to be in the closed position during the performance test period.

4.2.2 NPDES Operations Permit

FDEP was granted the power and authority to implement the federal NPDES regulatory program from the United States Environmental Protection Agency. In conjunction with the application for the EFA permit mentioned above, the District also submitted an application to the FDEP to modify the existing NPDES Operations Permit (FL0177946) for STA 2 to recognize the expanded treatment area. Issuance of the modified NPDES Operations Permit that recognizes the expanded footprint will be required prior to placing Cell 4 into flow-through operation. Construction of Cell 4 may commence prior to the issuance of the NPDES permit modification.

4.2.3 Consumptive Use Permit for Construction Dewatering

Construction of Cell 4 levees and water control structures will involve construction dewatering operations. Chapter 40E-2, Florida Administrative Code, requires that a Dewatering General Water Use Permit be issued by FDEP for these operations. The District had previously obtained a Master Dewatering General Water Use Permit (Number 0125539 GL) for ECP-related construction dewatering activities. This permit has been modified for new ECP related projects as needed. During the design phase of the project, an estimate of the dewatering volumes will be provided to the District and the District will submit a request for modification to FDEP for the master ECP dewatering permit for Cell 4 construction. Following contract award, the construction contractor will be required to submit a detailed dewatering and monitoring plan. Upon initiation of dewatering activities the contractor shall provide monthly volumetric summaries to document that the maximum monthly and total project allocations, as defined in the permit, are not exceeded.

The current plan is for all water from dewatering operations to be contained on-site. Since no water will be discharged off-site, an NPDES Generic Permit for the discharge of produced groundwater will not be required. Should the plan for on-site containment change, resulting in a need for off-site discharge, a NPDES General Permit will need to be issued by FDEP.

4.3 Palm Beach County Regulatory Requirements

The Palm Beach County Department of Environmental Resources Management (ERM) has approval requirements for land clearing operations, particularly those involving tree removal, and for certain types of excavations in agricultural areas of Palm Beach County. During the design phase of



the project, the District and Palm Beach County will decide what ERM permits, if any, will apply to the STA 2/Cell 4 Expansion Project. It may be that, if anticipated impacts are small, an exemption for de minimis impact, as provided for in the Palm Beach County regulations, will be applicable. Review of all structures that are subject to the provisions of the Florida Building Code may also require review and approval by the Palm Beach County Building Department. This review normally occurs when 100 percent complete, signed and sealed construction documents have been prepared and the project is ready to be advertised for bid. Once contract award has been made, the contractor pays the permit fee and is issued the Building Permit in his name. Improvements that may require Building Department approval include the inflow and outflow water control structures to Cell 4 and the modifications to the G-337A structure. Power supply for automated control gates, sampling equipment, and other on-site equipment may also require review and approval.



5. Hydraulic and Hydrologic Studies

5.1 Hydraulic Evaluations

Hydraulic evaluations were conducted to verify the sizing of the STA 2/Cell 4 inflow and outflow canal cross sections, establish diameter and invert elevations of culverts, identify crest elevations of weir control structures, establish levee heights and to determine the design of the internal works of the Cell.

5.1.1 Modeling Approach

HEC-RAS version 3.1.2, developed by the U.S. Army Corps of Engineers (USACE), was used to conduct the analyses associated with sizing the canals, culverts and control structures for STA 2/Cell 4 and to establish initial conditions for the FESWMS and CHAN models as discussed below. The steady flow component of HEC-RAS was used for these analyses. HEC-RAS computes water surface profiles from one cross section to the next by solving the one dimensional energy equation using the standard step method iterative procedure. The steady flow component is capable of modeling subcritical, supercritical, and mixed flow regimes through canals, river bridges, culverts, weirs, spillways and other structures (USACE, November 2002).

FESWMS/FIO2DH version 3.2.0, developed by Dr. David Froehlich for the Federal Highway Administration was used to conduct the analysis associated with the internal works of Cell 4. FESWMS/FIO2DH is a two dimensional finite element hydrodynamic model that can simulate two dimensional averaged flow velocities and water depths of surface water bodies such as floodplains, rivers and estuaries. The model can perform steady state or transient (time dependent) flow simulations subject to specified flow or specified head boundary conditions. The model can incorporate flow through internal structures such as culverts, weirs, drop inlets, road/berm overtoppings, and bridge structures. Cell 4 was modeled using the steady-state component of FESWMS. No internal water control structures were modeled in FESWMS in these analyses.

CHAN version 2.03, developed by Ghioto & DeLoach, Aquarian Software, Inc., was used to conduct the analysis associated with establishing the levee heights for Cell 4. Simulations with CHAN were conducted in an unsteady-state one dimensional model. CHAN simultaneously solves the modified St. Venant Equations for fluid flow consisting of conservation of momentum and conservation of mass. These two equations are solved using a relatively simple explicit finite difference technique which is subject to numerical stability criteria. CHAN also provides computation of flows through pumps, weirs, gates, orifices, culverts, bridges and drop structures as well as stages in channels, open water areas, ponds and lakes.



5.1.2 Flow Scenarios

The modeling was conducted for Cell 4 under three flow scenarios as defined in the scope of work:

- Low flow - 200 cfs (steady-state)
- Design flow - 1011 cfs (steady-state)
- Probable Maximum Storm (PMS) – 47.2 inches of rainfall over 24 hours plus 639 cfs of inflow to Cell 4 (replication of Cell 3 inflow for this scenario). This represents the inflow received from the S-6 and G-328 pumping stations for the PMS.

The low flow and design flow scenarios were simulated in HEC-RAS and in FESWMS. The PMS scenario was simulated in CHAN.

5.1.2.1 Low and Design Flow

The low and design flow scenarios were modeled in HEC-RAS to determine the following:

- Verify that the proposed canal cross sections and structure configurations have sufficient conveyance capacity so that inflows to Cell 4 can be conveyed under gravity flow based on the existing STA 2 configuration, i.e. that sufficient hydraulic gradient exists within the existing system
- Verify that the target stage in Cell 4 can be achieved for the low flow scenario within the normal operating stages of pumping station G-335. These target stages were established as varying between 1.25 and 1.50 ft above existing ground at the outflow control structure of Cell 4.
- Estimate inflow rates at Cell 4 inlet culverts, and water surface elevations at the downstream end of Cell 4, to establish boundary conditions for the FESWMS model

The Cell 4 inflow canal, cell body and discharge canal were modeled in HEC-RAS as a single river system. Boundary conditions were established for the Cell 4 HEC-RAS model based on previous modeling investigations of STA 2 (Cells 1 through 3). The boundary conditions were based on the water surface elevations established in the January 26, 1996 General Design Report, 30% Deliverable for the Detailed Design of STA 2 (GDR). The boundary conditions were established upstream and downstream of Cell 3, thereby bypassing Cell 3 as if it was off-line, at the locations where Cell 4 ties into the existing system.

Design Flow Boundary Conditions. The upstream boundary condition location was defined as 15.95 feet NGVD immediately upstream of the eastern most inflow culvert of Cell 3 in the inflow canal. The water surface elevation at this location is identified in the GDR in Table 4-2 and corresponds to the G-335 pumping station operating at 8.9 feet NGVD. The model output of the water surface elevation at this location was evaluated to ensure that the Cell 4 system had enough conveyance capacity to pass the design flow by gravity, i.e. the modeled water surface elevation is less than 15.95 feet NGVD.



As required under subcritical flow regimes (Froude number less than one), the HEC-RAS model requires that a physical downstream boundary condition be defined in the model. The downstream boundary condition was defined as the water surface elevation at the point where the Cell 4 discharge canal reach ties into the existing STA 2 discharge canal, downstream from existing structures G-332 and G-334. The downstream boundary condition was defined as a constant stage boundary of 9.54 feet NGVD. The water surface elevation at this location is identified in the GDR in Table 4-5 and corresponds to the G-335 pumping station operating at 8.9 feet NGVD. G-335 includes two 100 cfs pumps, two 470 cfs pumps and two 950 cfs pumps. The normal operating ranges for G-335 are as follows:

- Design headwater elevation: 8.9 - 13.1 feet NGVD
- Low headwater elevation: 7.5 feet NGVD

The locations of the boundary conditions are identified on the model schematic presented in Appendix E.

Low Flow Boundary Conditions. The GDR did not establish hydraulic grade line elevations for the low flow condition. Therefore, the same downstream boundary condition was adopted for the low flow condition as used for the design flow scenario. It was reasoned that the gradient downstream of G-332 and G-334 would be flatter for the low flow scenario. This would result in an elevation at the G-335 pumping station forebay higher than the minimum operational elevation of the pumping station; therefore, within the normal operational range of the pumps.

Model Configuration. Cell 4 was modeled in HEC-RAS as a single river system named “Cell4” with four reaches: Inflow canal, Cell 4 Ext, Collect Canal Ext and Discharge canal. The model schematic presented in Appendix E depicts the overall model configuration and identifies the reach names, junctions, and cross section locations relative to the various proposed structures.

The inflow canal was modeled as a reach named “Inflow Canal”. The reach was modeled starting at the existing STA 2 inflow canal at Cell 3, just upstream of the eastern most inflow culvert to Cell 3, to the G-337A structure. The canal cross sections for this portion of the model were entered based on information obtained in the GDR. The model of the Cell 4 inflow canal continues west to the G-337A structure that was simulated as gated orifices to represent the four gate openings (converted from the pump openings). The inflow canal reach continues south along the western side of Cell 3 from the G-337A structure in the existing seepage canal and it turns west along the northern boundary of Cell 4. The cross sections for this portion of the inflow canal were entered based on excavation volumes required to obtain sufficient fill material to build the levees alongside the canal. The inflow canal reach ends at a section 300 feet from the North New River Canal (NNRC) levee.

The model connects the inflow canal reach to the cell body reach by six 66-inch reinforced concrete pipe culverts, modeled as lateral structures under a levee running the full length of the north end of the cell body.



The spreader canal is the upstream most cross section of the cell at its northern edge. The cell body is represented in the model by cross sections of the reach named "Cell4Ext". The model includes several representative cross sections of the cell body obtained in a field survey carried out for this specific purpose.

The cell body and collector canal ("Collect Canal Ext") reaches connect to the discharge canal at a junction (J2) at the south end of the cell. In order to approximate the head loss produced by the Cell 4 flow change of direction when reaching the collector canal, the length of the junction along this canal was made equal to its total length. HEC-RAS requires a minimum of two sections per reach and an inflow value at its upstream end; therefore, "dummy" values were used for these parameters.

The headworks of the discharge canal contain the outflow control structure for the cell. The control structure consists of a weir with an effective length of 200 feet and crest elevation of 9.65 feet NGVD. The weir length of 227.5 feet shown in Figure C8 includes the length of the intermediate piers. The calculations associated with the weir design are included in Appendix E. Flow over the weir passes through four 8' x 8' box culverts under the levee into the Cell 4 discharge canal at the southwest corner of Cell 3.

The Cell 4 discharge canal reach ("Discharge Canal") is represented by cross sections of the existing seepage canal enlarged to provide sufficient fill to build the perimeter levee. This perimeter levee runs parallel to the existing Cell 3 and Cell 2 levees to form the embankment portion of the discharge canal. The discharge canal continues east along the southern boundary of existing Cell 3 and Cell 2. The Cell 4 discharge canal ties-in into the existing STA 2 discharge canal immediately downstream of structures G-332 and G-334 at the downstream boundary condition as discussed above.

Manning's n Values. The canal reaches were modeled with a Mannings "n" value of 0.044. The Manning's n values for the body of the cell (Cell4 Ext) were modeled based on a depth dependent relationship for submerged aquatic vegetation (SAV) obtained from the STA 2, 2-D Hydraulic Modeling Report prepared by the Sutron Corporation for the District in May 2004.

The HEC-RAS model input files are included in Appendix E.

The inflow rates into Cell 4 and the water surface elevation upstream of the outflow weir as established in the HEC-RAS model were used as input into the FESWMS model. The low and design flow scenarios were modeled in FESWMS to determine the following:

- Flow distribution throughout the cell
- Water depths throughout the cell
- Velocities throughout the cell



A complete description of the FESWMS modeling approach is included as Appendix F – STA 2 Cell 4 2-Dimensional Hydraulic Modeling, Taylor Engineering, Inc.

5.1.2.2 Probable Maximum Storm

The PMS scenario was simulated in CHAN in order to determine the water surface elevations predicted in Cell 4 under this rainfall event. The planned approach was to use historically computed stages from the GDR as a downstream boundary condition for analyses of the entire Cell 4 system within the FESWMS model domain. During this analysis, it was determined that the downstream boundary condition data were not available from the previous STA 2 modeling investigations. It was also determined that simulation of the inflow and outflow structures within FESWMS could not be accomplished and that the unsteady-state PMS scenario was not able to stabilize in the FESWMS model. Therefore, an unsteady simulation model became necessary to develop a time series of stages for the PMS within the cell, immediately upstream of the outlet structure. Due to the limited timeframe associated with the project, CHAN was used to model the PMS scenario.

As a result, CHAN was used to set a base case elevation at the south end of Cell 4 upstream of the structure. Since CHAN establishes water surface elevations as a flat pool, the FESWMS steady state internal head losses from the design flow condition (1011 cfs) were added to assist in determining the levee height. This methodology was considered conservative since friction losses associated with the much higher PMS event would surely be lower than under the design flow steady state condition.

The predicted water surface elevations were required inputs to the wave and wind run up analyses required to establish levee heights for the project. In order to understand the effects of the PMS on Cell 4, two models were constructed in CHAN that evaluate Cells 1, 2 and 4 of STA 2 operating as a system. Under the design criteria for Cell 4, Cell 3 is assumed to be off-line.

The first model, Case 1, constrains inflows to Cells 1 and 2 by specifying them as constant rates as calculated in the modeling studies conducted in the GDR. Inflow to Cell 4, through G-337A, is modeled as unconstrained flow with a headwater condition that is allowed to vary and thus result in the steady state design inflow rate of 1,011 cfs. However, during the PMS simulation, the G-337A discharge rate is tailwater influenced by stage conditions in Cell 4 allowing the inflow hydrograph to vary as well.

The second model, Case 2, allows inflows to Cells 1 and 2 to vary with internal cell water surface elevations and thus affect headwater conditions at G-337A. Cell 4 inflow is modeled as described for Case 1. Cells 1 and 2 are allowed to hydraulically interact with each other as well as Cell 4. Case 2 was added to evaluate whether the potential interaction of cells during the PMS would create a higher base elevation in the southern portion of Cell 4. It was also considered appropriate due to the simplified manner in which the model network represents the northern inflow structures and flat pool conditions within the cells. Additional detail was not added in the model because of time constraints involved in the model development and the reporting process.



Each model case was initiated by establishing the water surface elevation in the cells under design flow conditions prior to execution of the PMS unsteady simulations. Design delivery flow rates to Cells 1, 2 and 4 were specified upstream of the converted G-337A structure and flows were allowed to pass from an inflow node to each of the cells. The model was run for 700 hours to allow flows and stages in the network to stabilize dynamically under steady state conditions. An initial conditions file was then generated that could be used as a starting condition for subsequent PMS simulations.

The flow rates simulated for the design condition are presented in Table 5-1.

Table 5-1. Design Condition and Flow Rates

	Cell 1	Cell 2	Cell 3	Cell 4	Total Inflow
Design Inflow (cfs)	784.8	1483.0	Off-line	1011.0	3278.8
Case 1 – Constrained Inflow During PMS (cfs)	143.2	616.7	Off-line	639.0	1398.9
Case 2 – Unconstrained Inflow During PMS (cfs)	Varies based on hydraulic interaction of cells.	Varies based on hydraulic interaction of cells.	Off-line	Varies based on hydraulic interaction of cells.	1398.9

After the initial condition was generated, input flow files for the PMS rainfall were compiled based on a volumetric conversion of the rainfall event on an hourly basis. The rainfall hyetograph for the PMS is presented in Appendix G. Inflows simulated for Case 1 and Case 2 under the PMS are provided in Table 5-1 (above).

Model inputs to CHAN are generally as follows:

- Inflow canal – cross sections were imported from the HEC-RAS model input files
- Cell 1 – constant stage-area was assumed based on a surface area of 1783 acres
- Cell 2 - constant stage- area was assumed based on a surface area of 2382 acres
- Cell 4 – stage- area was assumed based on the surface area of the cell at average ground elevation (1924 acres) and an assumed top surface area (1950 acres)
- Outflow canal – cross sections were imported from the HEC-RAS model input files
- Existing Discharge Canal – cross sections were imported from previous modeling studies (GDR)

A schematic of the CHAN model is presented in Appendix G. Based on the model inputs, stages immediately upstream of the Cell 4 outlet structure were computed. The peak stage was used as



input for determining the wind setup and wave runup conditions (see below) to support levee crown elevation selection.

Complete model input files for CHAN are located in Appendix G.

5.1.3 Hydraulic Performance Criteria

The model simulations were conducted in order to design the various features of the Cell 4 system and to confirm that the design is within the hydraulic performance criteria specified by the District.

The following are the hydraulic performance criteria as discussed at the January 28, 2005 STA 2 Expansion Project Design & Operational Criteria Workshop:

1. Velocities in canals must be less than 2.5 feet per second.
2. The outflow structure should provide a depth of 1.25 – 1.50 feet at the downstream end of the cell under low flow conditions.
3. Velocities in the cell body must be less than 0.1 feet per second under design flow conditions.
4. The maximum allowable depth within the cell body is 4.5 feet (average over the cell body) under design flow conditions.
5. The minimum allowable depth within the cell body is 0.5 feet.

The HEC-RAS model was used to determine if the hydraulic performance criteria were met for item numbers one and two above. The FESWMS model was used to determine if the hydraulic performance criteria were met for item numbers three, four and five above. The results of the modeling indicate that the hydraulic performance criteria are met with a few minor exceptions. These exceptions are discussed below in the summary of the modeling results.

5.1.4 Summary of Hydraulic Modeling Results

The purpose and results of the HEC-RAS model are presented below in Table 5-2.

The HECRAS model output for the low flow and design flow conditions are presented in Appendix E.



Table 5-2. Summary of HEC-RAS Modeling Results

Purpose of HEC-RAS Model	Summary of HEC-RAS Model Results
Canal cross sections	See Figure C4 for the typical levee and canal sections
Structure configurations	See Figures C5 & C6 for inlet structure configuration. See Figures C7, C8 & C9 for outlet structure configuration.
Verify hydraulic gradient	Sufficient hydraulic gradient exists for Cell 4 to operate under gravity conditions for the low flow and design flow scenarios provided that G-335 is operated at 8.9 feet NGVD.
FESWMS Model Inputs	Inflow rates through the inflow culverts were provided for input to the FESWMS model. Water surface elevations just upstream of the outflow weir were provided as downstream boundary conditions for the FESWMS model
Confirm Hydraulic Performance Criteria for Canal Velocities	All velocities simulated in the inflow and outflow canals were less than 2.5 feet per second. Hydraulic Performance criteria satisfied.

The purpose and results of the FESWMS model are summarized below in Table 5-3.

Table 5-3. Summary of FESWMS Modeling Results

Purpose of FESWMS Model	Summary of FESWMS Model Results
Evaluate Flow Distribution within the Cell Body	Low Flow & Design Flows: Flows are generally evenly distributed throughout the cell. The area between the southern most west-east road and the collector canal has unit flows that indicate the flows are favoring a path towards the center of this area. This affect appears to be a result of localized ground depressions in this area.
Evaluate Water Depths within the Cell Body	Low Flow: All depths are greater than 0.5 feet. Water depths range from 0.9 feet to 2.6 feet within the cell body. Site features such as the fish farm, spreader and collector canals are at greater depths. Design Flow: All depths are less than 4.5 feet within the cell body. Water depths range from 1.9 feet to 3.8 feet within the cell body. Site features such as the fish farm, spreader and collector canals are at greater depths.
Evaluate Velocities within the Cell Body	Low Flow: Maximum velocity simulated within the cell body is 0.04 feet per second (fps). There are two areas of less than approximately 4 acres within the northwest and northeast corners of the cell that are stagnant under the low flow condition. The maximum velocity in the spreader and collector canals was simulated as 0.14 fps. Design Flow: Velocities are generally less than 0.1 fps. Although, a maximum velocity of 0.12 fps occurs in area of approximately 26 acres in the southern portion of the cell just north of the collector canal. The maximum velocity in the spreader and collector canals was simulated as 0.63 fps.

Non-uniform flow distributions in the cell, particularly in the southern portion of the cell north of the collector canal, are created as a result of localized ground depressions. Due to the limited



amount of topographic data used to develop the model's digital terrain model and mesh topography, it is recommended that additional topographic data be collected to better represent the actual extent of the low lying areas.

The FESWMS modeling results and recommendations are documented in detail in Appendix F.

The purpose and results of the CHAN model are presented below in Table 5-4.

Table 5-4. Summary of CHAN Modeling Results

Purpose of CHAN Model	Summary of CHAN Model Results
Determine Water Surface Elevation at the Downstream End of Cell 4 for the PMS	Results from the PMS simulations produced peak stages at the Cell 4 outlet structure of 15.05 and 15.14 feet NGVD for Cases 1 and 2, respectively. The more conservative Case 2 was chosen for use in subsequent analyses for wave and wind run-up analyses.

The CHAN model output for the PMS scenario is presented in Appendix G.

5.2 Wave and Wind Runup Analysis

Wave and wind run up analyses were conducted to evaluate the levee heights required for the project.

5.2.1 Levee Height Criteria

Profile grades for the exterior (perimeter) levees are established for the higher of the following minimum criteria as provided by the District:

1. To provide 3 feet of freeboard above the maximum design water surface
2. Sufficient to contain the increase above the standard project storm (SPS) resulting from wave runup (computed for the average of the highest one percent of waves) and wind setup resulting from Probable Maximum Hurricane wind
3. Sufficient to contain the increase above the PMS stages resulting from wave runup (computed for the significant wave) and wind setup resulting from occurrence of a 10-year wind

Profile grades for the interior levees are established for the higher of the following minimum criteria as provided by the District:

1. To provide 3 feet of freeboard above the maximum design water surface
2. Sufficient to contain the increase above the standard project storm (SPS) resulting from wave runup (computed for the average of the highest one percent of waves) and wind setup resulting from Probable Maximum Hurricane wind



Criteria numbers 1 and 3 (exterior levees) were evaluated to establish the required levee heights under the BODR. The north, west and south levees for the Cell 4 expansion project are considered exterior levees at this time. The east levee is considered an interior levee for the project. Based on a review of previous studies conducted in the project area for SPS and PMS water surface elevations combined with wave and wind runup analyses, the maximum levee height was generally determined based on criterion number 3 (GDR). In a few cases criterion number 2 was higher than criterion number 3 for the project area; however, the projected levee heights were only higher by 0.02 feet to 0.32 feet for the project area. Therefore, the levee heights established at this time in the BODR are considered to be sufficient for this phase of the project. The SPS simulation will be conducted under the detailed design work order in order to verify the levee heights for the exterior and interior levees of the project.

5.2.2 Results of Wave/Wind Analysis

The results of the wave and wind analyses indicate that the levees need to be established for the project at a minimum of 18.7 feet NGVD at the north end of the cell and 18.1 feet NGVD at the south end of the cell.

Refinement of modeling results and calculations of wave runup and wind setup during detailed design may result in minor adjustments to these preliminary levee elevations.

The methodology and calculations for the wave setup and wind runup are included in Appendix F. Tables 5-5 and 5-6 provide a summary of the wave setup and wind runup as included in Appendix F.

Table 5-5. Summary of Wave Runup and Wind Setup Calculations (Table 6.1 in Appendix F)

Conditions	
Avg. Water Depth	6.9 ft
Wind Speed	71 mph
Manning's n	0.15
Wave Breaker Index	0.6
Breaking Wave Height	4.1 ft
Fetch = 11,000 ft	
Wave Height, H_s	1.5 ft
Wave Period, T_p	2.4 sec
Wave Runup	1.7 ft
Fetch = 15,000 ft	
Wind Setup	1.2 ft
Wind Setup + Wave Runup	2.9 ft



Table 5-6. Summary of Top of Levee Elevations (Table 6.2 in Appendix F)

	North Side	South Side
DWS Water Elevation (ft NGVD)	11.6	11.0
PMS Water Elevation (ft NGVD)	15.8	15.2
PMS Water Depth (ft)	7.2	6.6
Top of Levee (DWS Stage plus 3' Criteria)	14.6	14.0
Top of Levee (PMS Stage + Wave Runup + Wind Setup)	18.7	18.1

5.3 Water Quality Evaluation

5.3.1 DMSTA

Modeling of the treatment performance of Cells 1 through 4 for STA 2 was conducted using the April 2002 version of the Dynamic Model for Stormwater Treatment Areas (DMSTA) to evaluate the performance of total phosphorus (TP) reduction over the STA. Cells 1 through 3 were modeled as they currently exist. The proposed interior levees as described in the Long Term Plan for Achieving Water Quality Goals, were not accounted for in the DMSTA simulations. DMSTA is a conceptual tool developed to predict phosphorus removal in STAs and incorporates much of the knowledge gained from the operation of existing full-scale STAs, as well as research studies into advanced biological treatment technologies.

However, there is scientific uncertainty associated with the modeling of STA performance. The analyses presented below incorporate the use of multiple calibration data sets and a range of flows to help address the performance uncertainties.

5.3.2 DMSTA Model Inputs

The model input values for Cells 1 through 3 were assigned the values as simulated in the paper titled *Strategy for Using Compartments B & C for Water Quality Improvement, working draft, July 2004*, SFWMD (Strategy Paper). The model input values used for Cell 4 in the Strategy Paper were reviewed by BC and modified as needed. The model input values for Cell 4 are discussed in detail below.

The inflow values and TP inflow concentrations used in the Strategy Paper (adjusted baseline data set for a 31-year period of simulation) were applied as the input series for the DMSTA simulations. The Strategy Paper describes this inflow data set as being adjusted for the period corresponding to 2007-2015 to increase the flows and reduce TP inflow concentrations to reflect observed values over the last three water years (as of July 2004). It should be noted that the District is currently developing a Regional Feasibility Study that will evaluate the District's overall STA systems and update the STA inflow data sets (flows and TP loads) as needed.



A summary of the modeling inputs for Cell 4 are as follows:

- **Vegetation Type** – Cell 4 was simulated using the vegetation data sets associated with SAV. DMSTA simulations were conducted with the SAV_C4 and STA2_C3 data sets.
- **Surface area** - Area of Cell 4 is based on the surface area at the average ground elevation of the cell (8.6 ft NGVD, 1924 acres) minus the area of the fish farm (22.5 acres) for a surface area of 1901.5 acres (7.695 km²).
- **Mean width of flow path** – The mean width of the flow path was calculated as approximately 2.5 km.
- **Number of Tanks in Series** - Three continuous stirred tank reactors (CSTR) were assumed for Cell 4. Three CSTRs is indicative of good hydraulic efficiency through the cell.
- **Outflow control depth** – The outflow control depth was determined based on the average optimum operating depth for SAV of 38 cm to 46 cm (1.25 ft to 1.50 ft) at the outflow of the cell. The outflow control depth was set at 42 cm.
- **Seepage rates** - The unit rate of seepage in the STA 2 area ranges from 3-4 cfs/ft-head/mile-levee. Therefore, an average value of 3.5 cfs/ft-head/mile-levee was used to determine the input values for DMSTA. The unit seepage rates for the project site are discussed further in Appendix C, Geotechnical Engineering Report. Seepage rates were determined for the seepage canal to the north of Cell 4, the NNRC and the seepage to the south of Cell 4 (Okeelanta). The control elevation for the seepage canal to the north was assumed to be equivalent to the control elevation of 9.0 feet NGVD of the existing STA 2 seepage canals. Based on a review of data in DBHydro (DBKey 6695) for the period of May 31, 1985 through December 28, 2004, the average operating level for the NNRC, north of the S-7 pumping station, is approximately 10.8 feet NGVD. This value was compared to the expected operating level of Cell 4 (at the south end of the cell as a conservative measure) of 9.975 feet NGVD. Therefore, it was determined that seepage from the NNRC will enter Cell 4. The land surface elevation of the property to the south was assumed to be equivalent to the average ground elevation of Cell 4. Table 5-7 provides a summary of the seepage rates calculated for Cell 4 for input to the DMSTA.
- **Seepage Control Elevations** – Seepage control elevations were determined based on the assumptions as discussed above for the seepage rates. A summary table of the control elevations (depths) calculated is presented in Table 5-8.
- **Seepage Total Phosphorus Concentrations** – The outflow seepage concentrations were assumed to be 20 ppb. The inflow seepage concentration from the NNRC was determined based on a review of data in DBHydro at the inflow side of pumping station G-370 for the period of March 2004 through February 2005. The average TP concentrations of 90 ppb during this time period was assumed to be the TP concentration of the seepage inflow to Cell 4 from the NNRC.



- **Seepage Recycle Fraction** – The seepage recycle fraction was assumed to be 0.78 (equal to the value assumed for Cell 3 in the Strategy Paper).

Table 5-7. Estimated Seepage Rates used for DMSTA Analyses.

Location	North (seepage canal)	West (NNRC)	South (Okeelanta)
Length (ft)	11900	13200	4700
Head Difference based on Cell 4 average operating depth (feet)	0.975	0.8	1.375
Seepage Rate (cfd/ft/ft)	26.1	-27.3	46.8
Total Seepage (cfd/ft)	310154	-360660	219927
Cell Area (acres)	1924		
Cell Area (ft ²)	83,809,440		
Loss Rate (ft/d/ft)	0.0037	-0.0040	0.0026
Loss Rate (cm/d/cm)	0.0037	-0.0040	0.0026
Combined Loss (cm/d/cm)	0.006	-0.004	

Table 5-8. Estimated Seepage Control Elevations Relative to Cell 4 Ground Elevation

Location	North (seepage canal)	West (NNRC)	South (Okeelanta)
Average Ground Elevation in Cell 4 (ft NGVD)	8.6		
Control Elevation (ft NGVD)	9.0	10.8	8.6
Relative to Average Ground Elevation (ft)	0.4	2	0
Relative to Average Ground Elevation (cm)	12	67	0

5.3.3 Projected STA Treatment Performance

The results of the DMSTA simulations, based on the adjusted baseline input data set (31-year simulated flow and TP loads) estimate STA 2 outflow TP concentrations ranging from 10-12 ppb for the geometric mean and 13-15 ppb for the flow-weighted mean with incorporation of Cell 4. The lower end of the ranges is associated with the SAV_C4 data set; whereas, the higher end of the ranges is associated with the STA2_3 data set. These results do not reflect the performance of the system under start-up conditions with the addition of Cell 4, i.e. vegetation establishment, antecedent soil conditions, etc.

It should be noted that the simulations conducted with the adjusted baseline input series and the SAV_C4 produced warning messages that the outflow concentrations from the cells were lower than contained in the SAV_C4 calibration data set. The simulations conducted with the STA2_3 data set did not produce any warning messages. The warning messages produced do not necessarily mean



that predicted outflow concentrations will not occur. The warning messages reflect that there is scientific uncertainty related to the predicted performance of the STA.

Simulations were also conducted for an increase of flow to STA 2. The inflows in the adjusted baseline input series were increased by 25 percent, and DMSTA simulations were conducted with the SAV_C4 and STA2_3 data sets. Results of the simulations estimate STA 2 outflow TP concentrations ranging from 12-15 ppb for the geometric mean and 15-18 ppb for the flow-weighted mean with incorporation of Cell 4 and a 25 percent increase of flows to STA 2.

The simulations conducted with the increased inflows to STA 2 for the SAV_C4 and STA2_3 data sets did not produce any warning messages.

The DMSTA model input and output files are presented in Appendix H.



6. Conceptual Design of Project Elements

6.1 Civil Design

The expansion of STA 2 by the implementation of Cell 4 is intended to provide additional treatment area of the existing inflows for further phosphorus reductions prior to discharge into Water Conservation Area 2A (WCA 2A). Under normal operations (low flow condition as evaluated in Section 5), Cell 4 will receive a portion of the inflow that currently is directed through Cells 1, 2, and 3, thereby reducing flows and phosphorus loadings to those cells.

Cell 4 will function within STA 2 as an independent operating unit. As with Cells 1 through 3, flow through Cell 4 can be independently controlled, or shut off and the cell taken offline as desired by the District. The hydraulic design criteria established for Cell 4 was based on replicating the original parameters used for Cell 3. The intention is for Cell 4 to normally share the loading with the other three cells and to act as the equivalent replacement of Cell 3 should it be offline for maintenance or other possible enhancement work.

The primary infrastructure improvements required for implementation of Cell 4 are shown on Figure C3 and include the following:

1. Upgrade a portion of the existing seepage canal along the northwest section of Cell 3 to serve as a portion of the inflow canal to Cell 4. Connect the new inflow (existing seepage) canal to the existing inflow canal at the west end of existing Cell 3 through the existing G-337A seepage pump station and plug the existing seepage canal upstream of this connection.
2. Remove the self cleaning trash screens, submersible pumps, and pump mount collars from the existing G-337A seepage pump station. Install motorized slide gates on the four pump inlet openings (40 inch x 80 inch) to control flow into the Cell 4 inflow canal.
3. Construct new inflow canal, six inflow structures, spreader canal, and associated levees along the north side of Cell 4. Permanent seepage management on the north side of Cell 4 will not be required. Temporary control to protect agricultural operations on the Woerner property will be accomplished using existing farm ditches and supplemental pumps. Agricultural operations are expected to cease a few months after startup with the eventual conversion of the area into additional STA.
4. Construct an interior levee along the east side of Cell 4 by utilizing the material from farm road degrading and from the collection and discharge canal excavations. Constructing an interior levee and allowing the existing seepage canal to remain provides the operating flexibility to convey inflow water from the S-6 pumping station to the South Build-Out Area or treated water from the North Build-Out Area to a discharge point in the south without affecting future operations in Cell 4.



5. Adjust the elevation of the existing NNRC East Levee to meet Cell 4 design requirements and to provide a uniform grade along the west side of Cell 4. As much as 3 or 3.5 feet of additional height will be needed at some points along the levee.
6. Construct a new collection canal, discharge water control structure, and perimeter levee on the south side of Cell 4. Note that seepage management on the south side of STA 2 will not be required as agricultural operations to the south have ceased with eventual conversion of the area into additional STA.
7. Upgrade the existing seepage canal south of Cells 2 and 3 to serve as an extension of the Cell 4 discharge canal and connect it to the existing STA 2 discharge canal downstream of the G-332 and G-334 structures. This connection will involve close coordination with Florida Power & Light (FP&L) because construction will occur within the easement for one of FP&L's 500 KW transmission lines and very close to an existing tower.

Primary access to the Cell 4 area is via the eastern NNRC levee which has a broad two lane unpaved roadway along the project boundaries. Access to the eastern NNRC levee is via cross bridges from US Route 27 traversing the west side of the canal. Access to this portion of the NNRC eastern levee is currently unrestricted.

The levees defining the inflow canal along the north edge of Cell 4 and the exterior levee along the south edge will tie into the NNRC eastern levee. The cell levees will be built in accordance with standard District design criteria including a minimum 14 foot top width and 3 horizontal to 1 vertical side slopes. The levee tops will support vehicle traffic. The north and south exterior levees will also connect to existing exterior levees of STA 2 creating complete traversable corridors across the entire expanded STA 2 system. Further discussion of site access is presented in Section 7.

In addition to the construction of the canals, levees and water control structures, work within the Cell 4 footprint will be required to prepare it for proper operation as a submerged aquatic vegetation (SAV) treatment cell. This work will include:

- Demolition of agricultural pump stations, associated piping and structures.
- Removal of various old equipment.
- Demolition of the PSTA test cell structures and levees.
- Degrading of containment levee surrounding the fish farm.
- Degrading of north-south embankments and backfilling the associated drainage ditches.
- Degrading embankments along the three interior east-west canals to an elevation established by the modeling. The canals will remain to aid flow redistribution.



- Clearing and grubbing of areas of heavy vegetation, apply vegetation management techniques to the remaining fields as described in Section 8.

Further details of anticipated site demolition and preparation work are shown on Figure C2.

6.2 Levee and Canal Design

6.2.1 Typical Levee Design

New levees will be constructed to create the flow ways and containment for the Cell 4 expansion. Levees will be constructed in accordance with District standard criteria including a minimum levee top width of 14 feet and minimum side slopes of 3 horizontal to 1 vertical (3H:1V).

Levee construction will be accomplished by conventional means similar to construction techniques utilized for the existing STA. Levee construction material will generally come from the excavation of adjacent canals. Approximately two feet of organic muck soil lies over hard limestone cap rock. The rock is sufficiently hard and competent that it requires drilling and blasting to break it up and to allow excavation and placement of the material as levee fill. Generally, levees will be constructed on top of the existing muck layer. Significant consolidation of the muck layer occurs, therefore, overfill of the levees is necessary for settlement compensation to achieve design heights. Leaving the muck in place, however, helps minimize seepage through the levee section. The muck is substantially less permeable than the relatively coarse nature of the rubblized rock and soil placed above it for the levee construction. The muck tends to help seal the base of the levee section aiding seepage control.

Typical levee and canal sections at various locations in the project are shown on Figure C4. Horizontal benches at existing grade level will be left between the toe of slope of levees and the top of slope of canal cuts. The benches will be approximately 20 feet wide. The benches aid material excavation and placement during construction, improve slope stability of the overall levee-canal section, and provide a future heavy equipment access way for future canal dredging or levee maintenance activities by the District.

Levee height was established using criteria consistent with the previous design of STA 2 as discussed in Section 5.2.1. Based on this analysis, preliminary levee height has been established at elevation 19.0 feet NGVD, which is consistent with existing elevations along the west and south exterior levees of Cell 3. Refinement of modeling results and calculations of wind setup and wave run-up may result in minor adjustments to this preliminary levee height determination.

Additional information on construction techniques, slope stability, and seepage evaluations of the proposed levees is presented in Appendix C – Geotechnical Engineering Report.

6.2.2 Typical Canal Design

New canals will be constructed for Cell 4 to convey source water inflow, distribution within and collection from the cell, and to convey treated water to the G-335 pumping station. Canal locations



are shown on Figure C3 and typical canal sections are shown on Figure C4. Canal size was generally determined by earthwork balance calculations to provide sufficient borrow material to construct the associated levees. As a result, the canals are larger than necessary for hydraulic conveyance of the design flows.

The canals will be constructed with 2H:1V side slopes in rock cut areas and 3H:1V side slopes in muck areas for slope stability. Actual construction of canals for STA 2 has shown that canal slopes can be cut nearly vertical and remain stable. Steeper canal sections help reduce seepage losses from the system. Exceptions shown are the inflow spreader canal and outflow collector canal. A top width of approximately 100 feet was established for these canals to enhance flow distribution and collection of outflows; therefore, these canals are shallower sections with 3H:1V side slopes.

Hydraulic conveyance in the canals was analyzed using the HEC-RAS model. The modeling results verified that the canal designs adequately conveyed the design flows without creating excessive head losses or velocities.

Additional information on construction techniques, slope stability, and seepage evaluations of the proposed canals is presented in Appendix C – Geotechnical Engineering Report.

6.3 G-337A Pumping Station Conversion

Inflows to STA 2 are supplied from the District's S-6 pumping station and G-328 by a supply canal constructed parallel to the L-6 Borrow Canal. The supply canal is connected to an inflow canal running to the west along the north edge of Cells 1 through 3. Inflow culvert structures are located along the length of the inflow canal to direct flows into the cells. The inflow canal originally dead ended at the northwest corner of Cell 3. A seepage collection canal was constructed immediately outboard of the STA 2 perimeter levee and seepage canal levels were controlled by pump station G-337 located at the northeast corner of Cell 1. G-337 returns seepage water to the inflow canal.

After operation of STA 2 began, the District became concerned about the ability of the G-337 seepage pumping station to adequately control such a large system from a single location. The District subsequently designed and constructed seepage pumping station G-337A in 2001. G-337A was constructed in the place of the end containment levee at the western end of the inflow canal (northwest corner of Cell 3). It is an approximately 77 feet long by 45 feet wide concrete structure with a 23 feet high bulkhead wall across the flow way. The bulkhead wall contains four 40 inch x 80 inch rectangular openings. Four horizontal submersible axial flow pumps (100 cfs capacity each) are mounted on the east side of the wall. The west side of the pumping station is connected to the seepage canal and powered self-cleaning trash racks are located on the west (inlet) side to protect the pumps from debris. The G-337A pump station also draws water from the seepage canal and pumps it into the west end of the inflow canal. According to District staff, the G-337A pumping station has operated only a few times since its construction.



Inflow source water to Cell 4 will come from an extension of the existing inflow canal. Several alternatives were evaluated for the point of connection of the inflow canal extension for Cell 4 to the existing canal, including demolition of the G-337A pumping station, going around it either to the south across the corner of Cell 3 or to the north, and conversion of the G-337A pumping station to a water control structure to allow water to flow through it.

It is the recommendation of the BC Team that the G-337A structure be left in place and converted to a primary water control structure for Cell 4. This would be accomplished by removing the self cleaning trash racks on the west side, removing the submersible pumps and mounting collars from the bulkhead wall, and installing weatherproof motorized slide gates over the four pump inlet openings on the bulkhead wall. Sufficient power and telemetry systems already exist at the pumping station for local and remote operation of the gates. Water quality entering cell 4 will be monitored by a water sampling station just downstream of the G377A structure.

Hydraulic modeling indicates that the gated openings are of sufficient size to pass the project design flows without creating excessive losses or flow restrictions. Modeling also indicates that excess head may exist in the inflow canal under normal conditions since Cell 4 is topographically lower than Cells 1 through 3; therefore, stage reduction in the inflow canal extension could be achieved at G-337A allowing the inflow culverts to Cell 4 to operate more passively. Utilizing the structure in this fashion would also create a positive shutoff point in the inflow canal.

6.4 Cell 4 Inflow Water Control Structures

Source water from the inflow canal extension will be introduced into Cell 4 through a series of six water control structures. These structures will be precast reinforced concrete pipe culverts, 66 inches in diameter, with concrete headwalls at the inlet and outlet ends. The inlet end of the culvert pipe will be equipped with an actuated slide gate to provide flow control as necessary and positive shutoff to the cell. Inlet inverts will be set at elevation 2.25 feet NGVD; therefore, the culverts will always operate fully submerged.

Culvert locations are shown on Figure C3. Hydraulic performance of the culverts was established using the HEC-RAS model. Culvert size was selected to deliver design flows without creating excess head losses or excessive velocities into the cell. Culvert placement was determined using the FESWMS model. Culvert locations are unevenly distributed based on the modeling to provide improved uniformity of flow distribution across the cell. A detailed discussion of the modeling performed is presented in Section 5.

Details of the inflow water control structures are shown on Figures C5 and C6. The design of these structures is in accordance with District standard design details. The slide gates on the inlet end will be equipped with weatherproof motorized actuators. Power will likely be provided by a new service drop from lines on U.S. Highway 27, brought across the NNRC and run overhead on poles from west to east along the inflow canal levee. Telemetry will be provided at each location in accordance with District standards for gate position indication and to allow remote operation of the gates.



Electronic water level monitoring gauges will be placed in stilling wells approximately 100 feet away from the upstream and downstream ends of two inflow culverts in the inflow and spreader canals. One set of gauges will be toward the eastern end of the cell and one set toward the western end. The gauges will also be equipped with telemetry for remote monitoring consistent with the existing STA 2 system.

6.5 Outflow Water Control Structure

A sharp crested weir structure located in the southeast corner of Cell 4 would control outflow from the cell. This structure would consist of 10, approximately 20-foot long bays separated by piers built on top of a cast-in-place concrete gravity wall on the limestone rock foundation. It is well known that discharge over weirs is affected, among other factors, by the distribution of velocities in the approach channel, the ventilation beneath the nappe, and the sharpness of the crest. A Cipolletti shaped trapezoidal weir has been selected because, when built according to the Bureau of Reclamation standards, they provide the highest degree of measurement accuracy. These weirs also provide other advantages, including the wide range of heads that can be reliably measured and the simplicity of construction and maintenance of the structure. The disadvantages of this type of weir are the need to dredge sediment periodically and keep the weirs free of weeds and trash.

Since the weir is located across the end of the collection canal, six bays have been placed directly across the flow path of the collection canal with the remaining four on either side to pick up sheet flow directly from the cell. The approach channel floor would be excavated at elevation 6.45 feet NGVD to maintain approaching velocities to a uniform one foot per second. The footprint of the proposed weir location within the cell is shown in Figure C7. An enlarged detail of the weir plan and details are shown in Figures C8 and C9, respectively.

Ventilation beneath the overflow nappe would be maintained by embedding small pipes running from under the nappe to the atmosphere along each bay weir length. A sharp and smooth surface weir crest would be provided by bolting a stainless steel plate to the upstream face of the concrete. The plate would be provided with slotted holes to facilitate adjustment during installation and for future structure movements and double nuts to prevent any possible vibration from dislodging the plate.

Hydraulic performance of the weirs and outlet culverts was established using the HEC-RAS model. Low flows around the minimum operating value of 200 cfs would flow freely over the weir provided the G-335 pumps maintain the water stage in the forebay at 8.9 feet NGVD. Higher flows up to the maximum operating discharge of 1,011 cfs would flow submerged unless the G-335 forebay can be pumped below 8.9 feet NGVD. The weir crest on each of the bays is set at 9.65 feet NGVD and the total weir length was set at 200 feet. This weir was designed to:

- Maintain a water level of 1.25-1.5 feet in the cell (just upstream of the outflow structure) under low flow conditions.



- Pass the maximum design flow (1011cfs) while keeping water depths in the cell under 4.5 feet.
- Provide a no flow dry-out protection depth of approximately one foot in the cell.

The energy of the water flowing over the weir would be dissipated in the deep pool (minimum depth of 9.6 feet) provided downstream of the weirs. This same pool forms the headwaters of the four 8 feet by 8 feet reinforced concrete box culverts carrying outflows under the east levee into the discharge canal. The invert of these culverts has been placed at -2.5 feet NGVD in order to maintain a minimum submergence of half the culvert rise during the full range of operating scenarios. Compaction of the levee embankment around and over these culverts would be carefully specified during the design phase to prevent the possibility of piping along their interface.

The culverts will have the capability of being isolated by using needle beams installed in slots on the structure. The needle beams would be installed under balanced head conditions and dewatering would take place by lowering a sump pump into the culverts.

The culverts will join the discharge canal through a flared reinforced concrete transition designed to gradually decrease the culvert velocity to the smaller discharge canal values. The possible need to riprap the discharge canal will be examined during detailed design.



7. Other Project Considerations

7.1 Environmental Issues

A discussion of environmental conditions and assessments is presented in Section 2.2 of this report. Regulatory considerations and permitting requirements are presented in Section 4. Specific environmental issues impacting the implementation of the Cell 4 project include the determination of jurisdictional wetland boundaries within the footprint and potential toxaphene impacts in the portion of Compartment B lands known as the Woerner South Farm 2.

As discussed in Section 4, the determination of the extent of jurisdictional wetlands is an important part of the 404 permitting process currently underway with the U.S. Army Corps of Engineers (USACE). The limits of wetland areas and timing of securing the 404 permit will impact the timing and extent of when construction activities can begin. Specifically, site preparation activities, as discussed in Section 8.1 of this report, will be impacted and the overall project schedule could potentially be delayed.

As a part of environmental assessment activities being conducted by the District on Compartment B lands, the potential impacts of toxaphene are being investigated on the Woerner South Farm 2 area immediately north of the Cell 4 location. While sampling and analysis results for the entire property are under evaluation by the District and the U.S. Fish and Wildlife Service, a specific sampling program was undertaken by Environmental Consulting & Technology, Inc. (ECT) for the 200 foot wide strip of land along the eastern edge of the Woerner parcel (western edge of cell 3) that will be utilized for the inflow canal extension corridor for Cell 4. Results of the sampling program are presented in a letter report prepared by ECT to the District, dated December 15, 2004. The report concludes that soils within the corridor do not pose a significant risk to trustee species of birds, fish, or sediment dwelling organisms and development of the area should be deemed acceptable. A copy of the report is contained in Appendix I.

7.2 Site Security

Primary access to Cell 4 will be via the unpaved roadway on the North New River Canal (NNRC) east levee. The east levee is accessible from Highway 27 at several bridge crossing locations. Currently, public access across the bridges and travel on the east levee is unrestricted in the vicinity of the project. Current access into the interior of the Cell 4 area along existing farm roads is restricted by locking gates.

As discussed in Section 6, access to the interior of Cell 4 will be along the north and south exterior levees which will tie into the NNRC east levee. Locking gates will be installed at these locations to prevent unrestricted vehicle traffic onto the Cell 4 levees. The NNRC east levee does present an unusual situation for site security since it is expected to also serve as the western operating levee for the cell. Options for site security would include:



- Leave access to the NNRC east levee open and unrestricted, thereby leaving the west side of the cell unrestricted
- Construct a fence along the west edge of the cell to prevent entry while leaving the levee unrestricted
- Construct locking gates at the cross bridges and across the NNRC levee at the north and south limits of the project to restrict vehicle access to the levee and the cell

The appropriate level of site access control and restriction will need to be determined by the District with the control measures included in the detailed design.

7.3 Recreational Benefits

As a part of its overall program for STA development, the District has undertaken a directive to improve public access and benefits through recreational use opportunities. Recently, certain STA areas have been opened to limited waterfowl hunting under controlled access conditions.

The construction of the Cell 4 expansion of STA 2 potentially improves public access since its western boundary will be the NNRC eastern levee, as discussed in Section 7.2. Development of a recreational plan for Cell 4 should be performed as a part of an overall plan developed for the Compartment B land. Potential recreational activities include:

- Hiking and biking along the levee system
- Bird watching and wildlife observation
- Limited hunting
- Information kiosks

It is anticipated that the design of Cell 4 will include enlarged turnouts dispersed along the levee system and enlarged radius corners at levee intersections to accommodate vehicle traffic and pullover areas.

A unique feature in the Cell 4 area is the abandoned rock quarry/fish farm area. This is an approximately 22.5 acre former borrow pit that was later utilized for a period of time as a commercial fish farm operation. The quarry varies from approximately 15 feet to 25 feet in depth. The conceptual design of Cell 4 presented in this BODR includes the fish farm area inside the levee system and within the footprint of the cell. Although it will not provide effective treatment area, the fish farm has been found not to create a significant loss of water through seepage and will not have a significant impact on flow distribution through the cell.

Access to the fish farm area is from the NNRC levee road. A raised parking area currently exists which was last used as the contractor field office location during the construction of STA 2.



7.4 Public Impacts

No potentially adverse public impacts have been identified during the development of this project. This site is remotely located in south central Palm Beach County in an area of previous agricultural activities. The site is surrounded by active agriculture and water management areas. Disturbance of jurisdictional wetlands will be accounted for in the District's Everglades Forever Act (EFA) mitigation program. The design of the levee system is based on containing the Probable Maximum Storm event to mitigate flooding issues. Seepage losses from the system will be appropriately controlled and will not impact adjacent landowners.

Positive public impacts include improved water quality delivery to the water conservation areas as prescribed by the EFA and potentially enhanced access and recreational opportunities associated with the development of the STAs.



8. Project Implementation

8.1 Construction Approach and Schedule

Implementation of the Cell 4 expansion of STA 2 is a part of the overall plan by the District to achieve the objectives set out in the Long Term Plan. As a result, the project objective is to have Cell 4 flow capable by December 31, 2006. Construction timeframes necessary to achieve this goal are estimated to be greater than twelve months. Sufficient time may not be available to complete the Basis of Design process, complete detailed design, bid and procure a construction contract, and execute construction in a conventional manner under a single contract to achieve this goal.

The proposed Project Schedule is shown in Appendix J. This schedule presents an alternative approach recommended by the project team to accomplish construction under multiple contracts. Essentially two or more contracts would be prepared and procured to implement elements of the project work. As described in Section 6, significant preparation of the Cell 4 site will be required to prepare it for construction of the main components and for establishment of submerged aquatic vegetation (SAV). The schedule presents the approach of preparing Site Preparation Contracts upon completion of the BODR phase simultaneously with the development of the detailed design. Site preparation activities could begin as early as July 2005.

The first anticipated contract would provide for demolition of existing farm facilities including old drainage pump stations, abandoned farm equipment, removal of drainage culverts from the NNRC levee, and removal of water control structures associated with the PSTA test cell. This work can proceed without obtaining the Section 404 permit and, therefore, could begin as soon as contract documents are prepared.

The second anticipated site preparation contract would provide for degrading of farm roads, filling of north/south ditches and canals and removal of the fish farm and PSTA cell levees will run from August 2005 to October 2005.

Completion of the site preparation work will be followed by construction of the principal infrastructure improvements including the canals, levees, and water control structures. These improvements are expected to be constructed under a single contract developed during the detailed design phase. It is anticipated that approximately twelve months will be required to achieve flow capable status in Cell 4; therefore, construction must begin no later than January 2006.

The actual construction sequence will be established by the selected contractor with the requirement of achieving flow capable status in Cell 4 by the end of December 2006. Flow capable status will mean that all canals and levees have been constructed to sufficient height to allow permanent filling for establishment of SAV, water control structures are operational at least by manual means, and startup testing is in progress. It is anticipated that final construction will not be completed until mid-2007.



Construction water including precipitation runoff and dewatering is anticipated to be managed primarily by pumping it back to the inflow canal of STA 2 for processing and treatment through the system. This will initially be accomplished by connecting the existing drainage canals within the Cell 4 area to the existing seepage canal along the west side of Cell 3. Water in the seepage canal is pumped back into the inflow canal by the G-337 seepage pumping station. This initial connection will occur mid-2005 to begin drying down the cell to accommodate the demolition and site preparation work. It is anticipated that the Cell 4 area will be kept in a “dried down” state through construction until final vegetation management operations have occurred and final filling of the cell commences.

Wet season flows may exceed the capacity of the G-337 pumping station; therefore, supplemental pumping will need to be provided. This may initially be accomplished by activation of one or more of the pumps in the G-337A seepage pumping station located at the northwest corner of Cell 3 at the west end of the inflow canal.

Additional water will be generated during the main construction as active dewatering pumping is performed by the contractor for canal and structures installation. It is anticipated that this water will also be managed back to the inflow of STA 2. Additional supplemental pumping equipment will be provided by the contractor to ensure proper operating levels are maintained in the seepage collection canal to protect adjacent lands.

The site water management plan is currently being developed with BC and the District operations group to address flow estimates, operational requirements, monitoring and reporting requirements, and supplemental pumping operations. Further definition of the plan will be presented in the 30% design documents.

8.2 Opinion of Probable Construction Cost

An Opinion of Probable Construction Cost for the Cell 4 expansion presented in this BODR is contained in Appendix K. The total estimated cost of construction, including a 30% construction contingency, is \$14,288,019. The Opinion of Probable Construction Cost was developed in accordance with Acceler8 Program guidance provided by the District. Details of the preparation of the estimate and the line item breakdown are presented in the appendix.

8.3 Preliminary Operations Plan

8.3.1 Startup

Operational startup of Cell 4 will actually begin with the early stages of site work. Upon completion of interior clearing, demolition, degrading, and vegetation management work as described in Section 8.1. By mid-October 2006 the cell will be drawn down and allowed to dry out as necessary. Mid-December the vegetation will be controlled using a combination of herbicides burning and/or



mowing. Filling of the cell will begin immediately after completion of the final vegetation management procedures to begin the establishment of the SAV to prepare the cell for operation.

Startup testing will be required in Cell 4 before flow through operations can begin. The Everglades Forever Act (EFA) permit modification will be written such that there cannot be any discharge from Cell 4 until it passes net reduction tests as identified in the EFA permit. The net reduction for phosphorus shall be deemed to occur when the 4-week geometric mean total phosphorus water column concentration from samples collected at the Cell 4 outflow structures is less than the 4-week geometric mean total phosphorus water column concentration collected at S-6 pumping station. The net reductions for total mercury and methyl mercury shall be deemed to occur when the water column concentrations for total and methyl mercury at a chosen midpoint of Cell 4 are not significantly greater than the concentrations of the corresponding species at S-6. During the startup testing period after the initial filling, additional inflows will not be introduced and water will not be discharged from Cell 4. Upon successful completion of the net reduction tests, Cell 4 flow through operations can begin as will be described in the final Operations Plan.

8.3.2 Normal Operations

Cell 4 will be supplied by water from the existing STA 2 inflow canal as supplied by the S-6 and G-328 pumping stations. Water to the cell will be directed through the converted G-337A water control structure where primary flow and stage control can be monitored and adjusted by the District. Inflow to the cell will be through six water control structures along the north control levee. The structures are 66 inch diameter reinforced concrete pipe culverts with full flow slide gates. Two pair of level indicating transmitters (LIT) located between the first and second and the fifth and sixth inflow structures will provide real time water surface elevations on both the supply and discharge pools. The inflow structure gates will be capable of both local and remote operation to any position from the District's central control room. The culverts will be totally submerged at all flow ranges. Power for the gate controls and instrumentation shall be supplied by Florida Power & Light. Backup power for the instrumentation shall be four hour UPS battery systems. All gates shall be backed up by portable gasoline powered operators.

Water will be sampled at both the inflow canal and at the cell discharge. Standard District sampling stations will be installed.

The cell discharge will be controlled and measured by means of a weir located upstream of the discharge outflow culverts located at the southeast corner of Cell 4. This shall consist of four 8 feet X 8 feet box culverts with dewatering bulkhead slots on the upstream end to receive stop logs for positive cell isolation.

LIT's will be installed upstream and downstream of the weir to measure flow over the weir crest. The weir crest is set at 9.65 feet NGVD, approximately 1.1 feet above average cell floor elevation.

The water level in the discharge canal shall be maintained at or below the desired Cell 4 operation level by the G-335 pumping station. This may require that the water level in the existing discharge



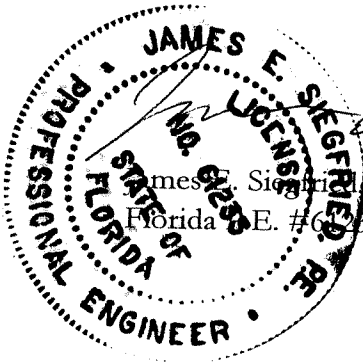
canal be maintained at levels lower than historical operation of the current STA 2 system to avoid backflooding of Cell 4. Additional operational impacts may be seen at the G-334 and G-332 structures to maintain proper operation of Cells 2 and 3 as a result. The Cell 4 design flow will be conveyed through the system if the water stage at the G-335 pumping station is maintained at 8.9 feet NGVD in accordance with the current operations plan.

Since STA 2 is included in an existing EFA permit, the expansion into Cell 4 will be permitted by FDEP as a modification to that permit. It is likely that there will be no new permit-related monitoring requirements specific to Cell 4. However, the District will likely monitor treatment performance in Cell 4 for the purpose of operational control. In conjunction with the application for the EFA permit, the District also submitted an application to the FDEP to modify the existing National Pollutant Discharge Elimination System (NPDES) Operations Permit for STA 2 to recognize the expanded treatment area. Issuance of the modified NPDES Operations Permit that recognizes the expanded footprint will be required prior to placing Cell 4 into operation.



9. Signature and Seal

I hereby certify as a Professional Engineer in the State of Florida that the work documented in this report was completed under my direct supervision. This certification is made in accordance with the provisions of the Laws and Rules of the Florida Board of Professional Engineers under Chapter 61G15-29, Florida Administrative Code.



James F. Siegfried, P.E.
Florida P.E. #61233